# Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

SOLOGY DEPT.
10 EMPIRE BUILDING | OCTOBER, 1945 | OCT 29 1945 | PITTSBURGH, PA.

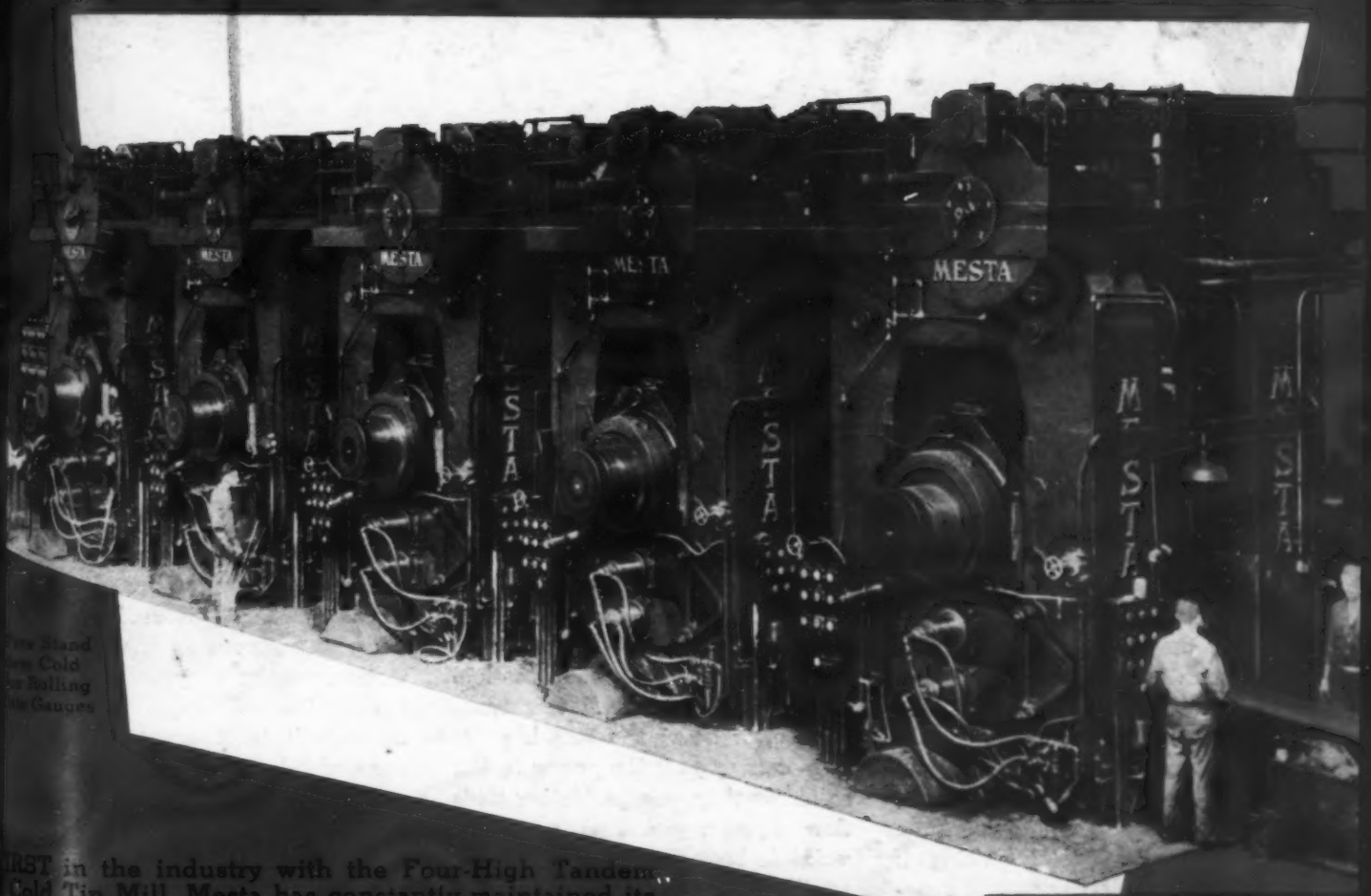


MESTA

HIGHER SPEED

Four High Tandem

COLD MILLS




IRST in the industry with the Four-High Tandem Cold Tin Mill, Mesta has constantly maintained its ition of leadership, and is building mills with delivery eds which yesterday were considered impossible. These mills ize new types of drives and control systems which maintain chronization during acceleration, deceleration and at normal rating speeds.

The Army-Navy "E" Flag with five stars flies over the Mesta Plant

BUY VICTORY BONDS

MESTA MACHINE CO., PITTSBURGH, PA.

# Important News for Every User of Electric Power

## *Now... A New Safety Switch that solves the long-standing problem of INTERNAL HEATING!*

Safety switch users and designing engineers have long puzzled over a vexing problem of safety switch performance. All too often, perfectly good-appearing switches proved inoperative after a relatively short period of normal use. What made the problem a real mystery was the fact that many of these switches had been "used" . . . opened and closed . . . but a very few times. And some had not been operated at all since the day they were installed. Why, after months of "doing nothing", should the blades of these switches become welded in place so they could not be moved? This was a vital question because the main purpose of a safety switch is *safety*—to provide a sure means of completely cutting off the electrical power supply to a machine in that breathless moment of an emergency when an anxious hand tugging at the handle of a safety switch *must* get results.

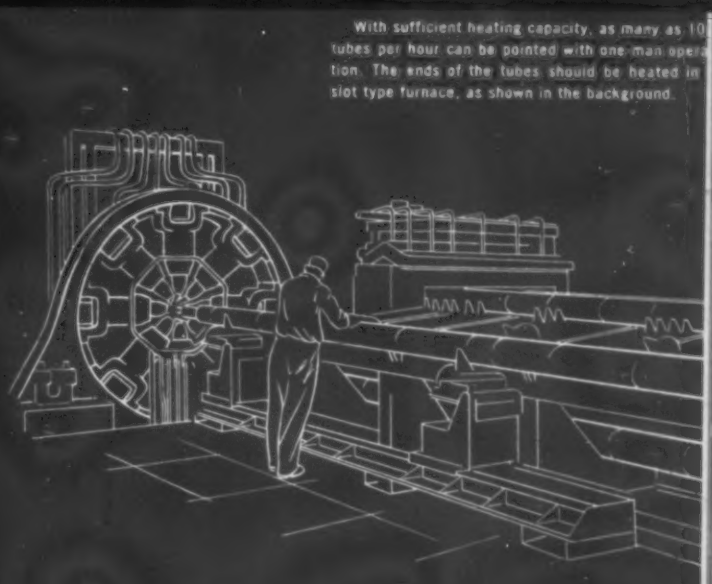
Cutler-Hammer engineers found the answer to this problem of welded switch contacts, strangely enough, within the "nothing to do" life which all safety switches lead. They found that safety switches were far from idle during the months and months of seeming inactivity while they were simply standing guard for a possible emergency. During all this time, hour after hour, the switch parts were carrying *all* the power to the machines they were protecting. This flow of power generated much unavoidable heat which literally *baked* the life out of the switch mechanism. This baking caused the switch contacts to gradually relax their grip on the blades which they held so tightly when new. This lessening contact pressure produced sparking . . . then arcing . . . then *welding* of the contacts. Here, then, was the secret of most safety switch troubles. Internal heating, *time-welded* contacts! Today an entirely new line of Cutler-Hammer Safety Switches is ready to bring your men and equipment protection worthy of your insistence. Specify Cutler-Hammer and refuse any substitute. Carried in stock by recognized electrical wholesalers everywhere. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin.

**CUTLER-HAMMER**
**SAFETY SWITCHES**
**C-H**

*Now*

# AETNA-STANDARD

## announces a new machine for pointing heavy wall steel tubes



With sufficient heating capacity, as many as 10 tubes per hour can be pointed with one man operation. The ends of the tubes should be heated in slot type furnace, as shown in the background.

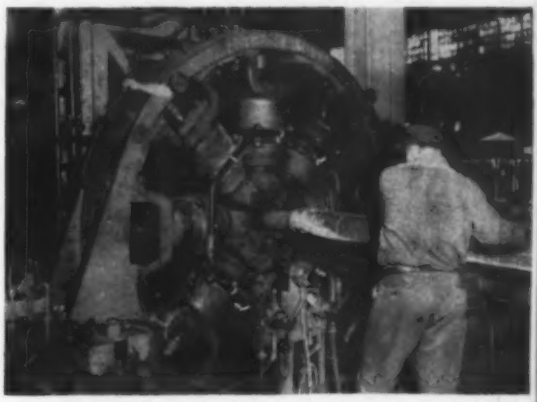
*Out goes the old . . . in comes the new!*

**This revolutionary Aetna-Standard machine points heavy wall steel tubes *3 times as fast and at much less cost* than the old stand-by—the hammer method.**

**In pointing all sizes of steel tubes from 5" O. D. and up, the hydraulic squeeze pointer exerts more than a million pounds pressure. It eliminates all hard, manual labor, and one operator can point as many tubes with the new squeeze pointer as three crews can with the conventional method . . . proved by operating records of an installation in one of America's foremost tube mills.**

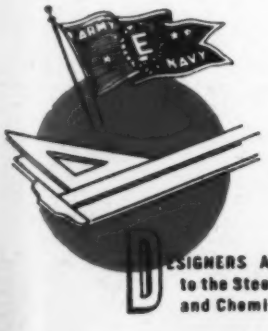
**The hydraulic squeeze pointer takes its place alongside many other notable Aetna-Standard achievements. Our business for 44 years has been that of originating and building of machines to increase production, reduce costs, and improve products of the ferrous and non-ferrous industries.**

Tubes can be pointed in the squeeze pointer at a lower temperature than with a hammer.



For pointing larger diameter tubes, Aetna engineers recommend 8 dies and for smaller tubes, 4 dies. The dies, which can be changed in a few minutes, are hydraulically synchronized during the full forward and return strokes.

Here is an 8½" O. D. tube, ¾" wall, which has been pointed to a diameter of 4 inches. Notice the opening at the end of the tube is open, an advantage of the pointer which speeds up the operation of pickling and washing out of scale.
Straight concentric points facilitate gripping in carriage and also provide improved inside and outside contact points for die and plug. Length of straight portion can be made to suit individual requirements.



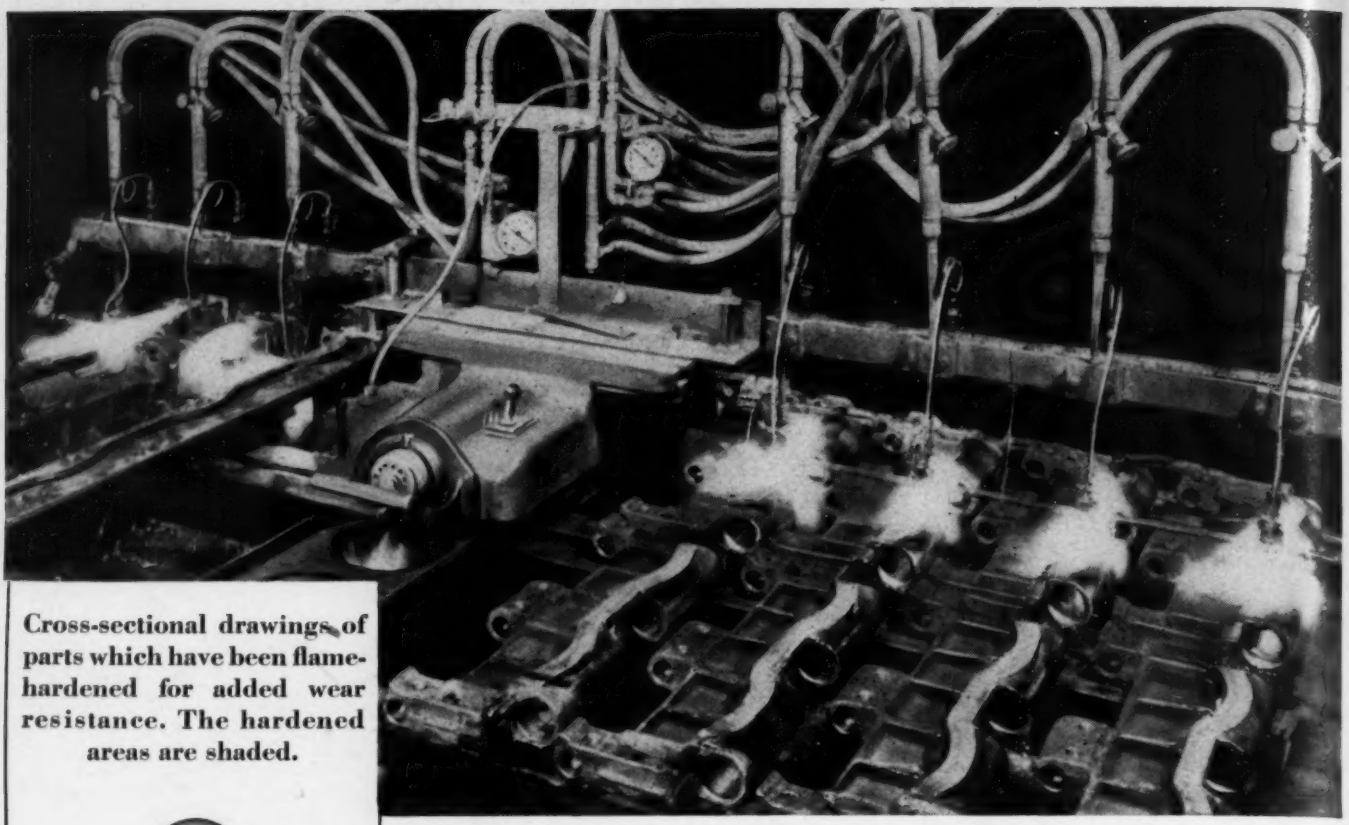

**THE AETNA-STANDARD ENGINEERING COMPANY**

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

YOUNGSTOWN, OHIO

*ASSOCIATED COMPANIES:*

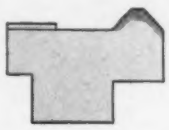
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA



**Cross-sectional drawings of parts which have been flame-hardened for added wear resistance. The hardened areas are shaded.**

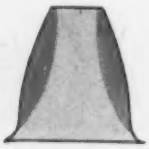
Shaft

Crankshaft Bearing



Lathe Way

Sheave Wheel



Gear Tooth

# *You Get Greater Wear-Resistance Where Needed with Oxy-Acetylene Flame-Hardening*

Oxy-acetylene flame-hardening as developed by Linde is a completely automatic process which can be applied at production-line speeds. In the picture above seven tank tread shoes are being flame-hardened simultaneously. The entire operation takes less than 4 minutes.

The oxy-acetylene flames, followed by a cold water quench, give the wearing surfaces of the treads a uniform hardness — controlled to a depth of 3/16 in.— without affecting the chemical composition, ductility, or toughness of the core or surrounding areas.

A variety of steel and cast iron parts can be hardened easily by Linde's method. Even parts too large to be hardened by other methods can be flame-hardened at exactly the points where wear occurs...and without distortion.

You can get the flame-hardening apparatus and supplies you need from Linde, and Linde can show you how to use them.

Write for the booklet, "Flame-Hardening," Form 4726.

**BUY AND HOLD UNITED STATES VICTORY BONDS AND STAMPS**

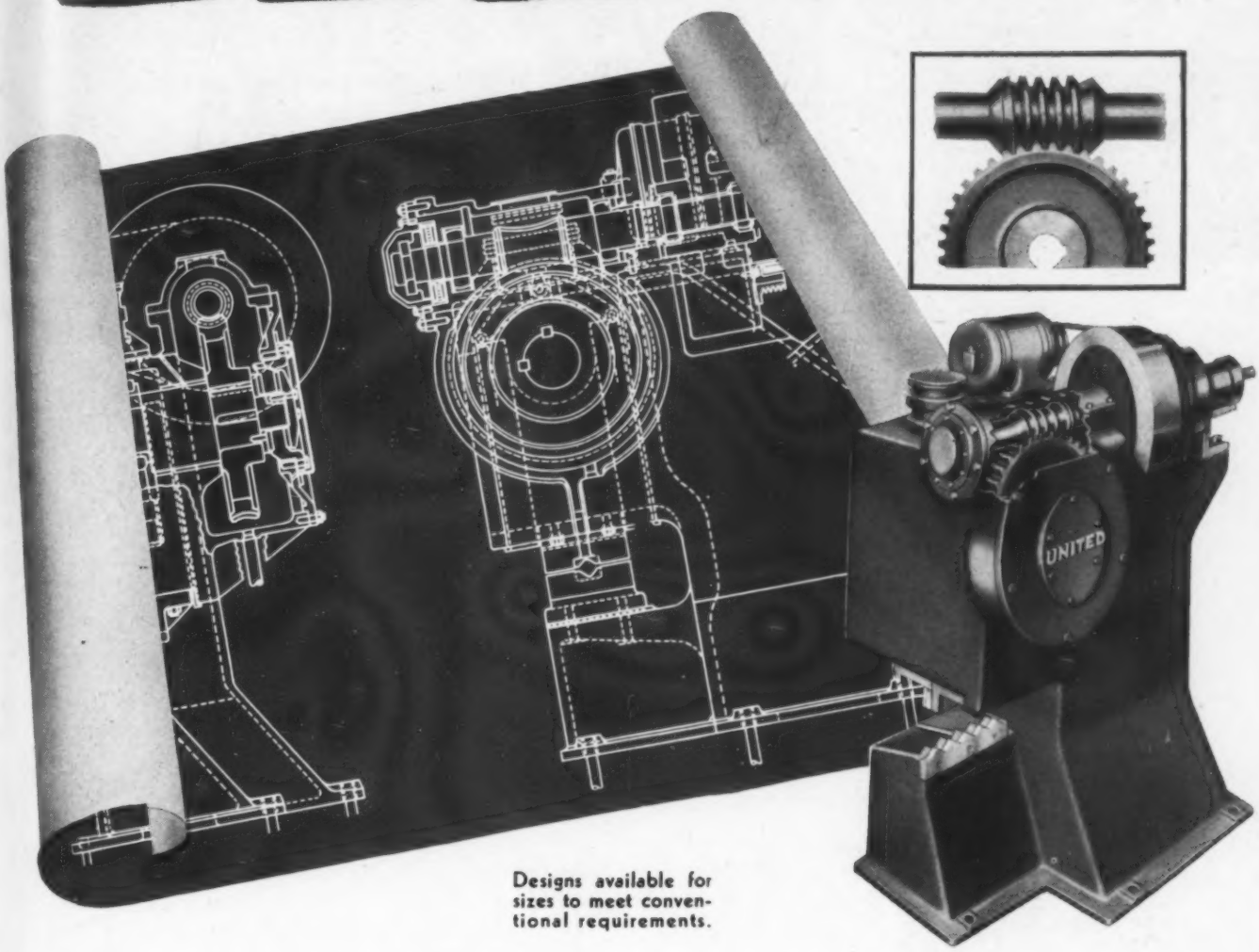
**THE LINDE AIR PRODUCTS COMPANY**

*Unit of Union Carbide and Carbon Corporation*

30 E. 42nd St., New York 17, N.Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

# a new UNITED
# Cone Worm Driven VERTICAL SHEAR




Designs available for sizes to meet conventional requirements.

- CONE WORM GEARING assures uniform power . . . smooth, quiet operation.
- Simple rugged construction assures longer service life.
- Fewer moving parts reduce maintenance expense.
- New compact design materially reduces overall dimensions.
- Fully enclosed gears.
- Forced oil lubrication.
- Equipped with either straight or grooved knives.

Write for complete technical data or consult our engineers concerning special designs for specific requirements.

**United Engineering and Foundry Company**

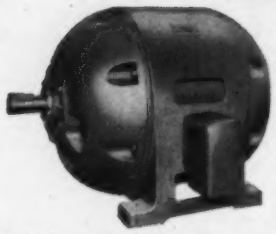
**Pittsburgh, Pennsylvania**

Plants at PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON
Subsidiaries: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

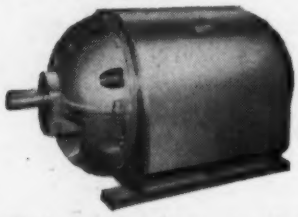
*The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

# NOW your *big drives* can have it* too!

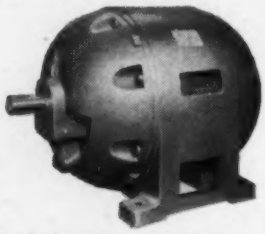
*The EXTRA protection of TRI/CLAD construction



Typical, large-size, sleeve-bearing Tri-Clad polyphase motor, now standard up to 2000 horsepower



Modified cast-iron frame construction used for certain large sizes of the extended Tri-Clad motor line



Separable housing construction used for large-size ball- or roller-bearing Tri-Clad motors. Roller bearings are standard at coupling end

## G-E STANDARD Tri-Clad Induction Motors Now Available to 2000 Hp.

**For that important *big* drive (up to 2000 hp, 3600 rpm) you can now get a G-E standard Tri-Clad induction motor with all the protective features that have proved so valuable in the more widely used sizes.**

● **1. EXTRA PROTECTION FROM PHYSICAL DAMAGE**

Cast-iron construction with upper portion completely enclosed to keep out falling objects, dripping liquids. Streamline, cast-iron end shields. Corrosion-resisting finish.

● **2. EXTRA PROTECTION FROM ELECTRICAL BREAKDOWN**

Windings of Formex wire are solidly bonded with synthetic resins that are strongly resistant to oil and moisture. Formex wire insulation stands up remarkably under abrasion or "heat-shock."

● **3. EXTRA PROTECTION FROM OPERATING WEAR AND TEAR**

Available with either sleeve or ball bearings—in dust-tight housings. Sleeve-bearing design is a further refinement of well-proved Tri-Clad motor bearing proportions, efficiently lubricated, with "air seal" to insure oil-tightness of the housing.

**The Tri-Clad, in its wide range of types and sizes, is G.E.'s most widely used (integral-hp) motor. Chances are there's a Tri-Clad to meet your drive requirements "on the nose." Ask for Bulletin GEA-3580.** ***General Electric Company, Schenectady 5, N. Y.***

**NEW 2000-hp INDUCTION MOTOR LARGEST MEMBER OF TRI-CLAD FAMILY**

Dwarfing the original Tri-Clad motor (resting on the conduit box) in size, this new 2000-hp "big brother" embodies all of the same protective construction features. It operates at 1800 rpm, on 2300 volts, 60 cycles. This new 3-phase motor is in the 6360-frame series, which is five steps larger than the largest standard industry frame size (namely 505).

| Here's Today's Wider Range of Standard Sizes | |
|---|---|
| **TYPE K** | **1 hp to 2000 hp at 1800 rpm** |
| **TYPE KG** (High starting torque, low starting current) | **5 hp to 200 hp at 1800 rpm** |
| **TYPE KR** (High starting torque, high slip) | **Available to 100 hp in speeds required for high-slip, flywheel drive (punch presses, etc.)** |

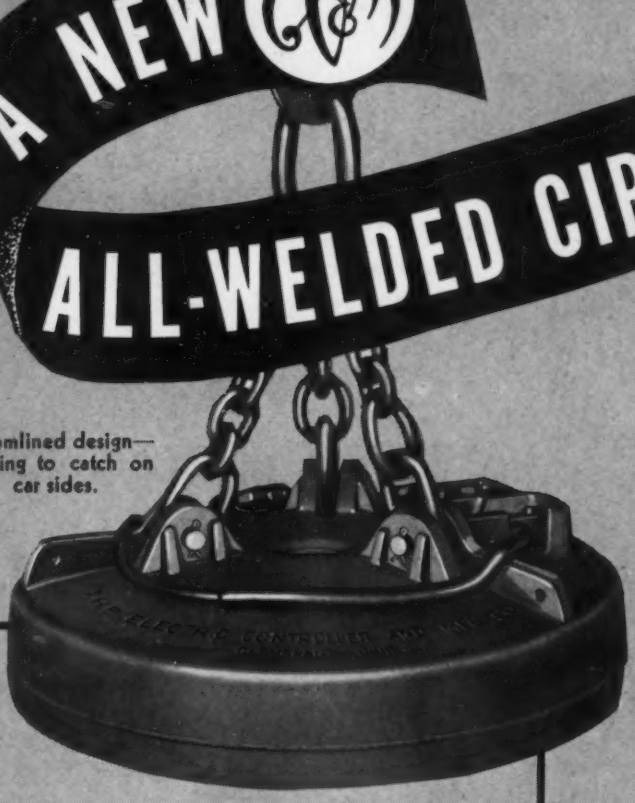
**Special motors can be custom-built in Tri-Clad design for YOUR problem.** Induction motors specially designed to the job can generally be built with many of the Tri-Clad motor's strong points, such as enclosed upper portion, smooth cast-iron end shields, windings of Formex wire, and double-end ventilation.

**GENERAL ELECTRIC**

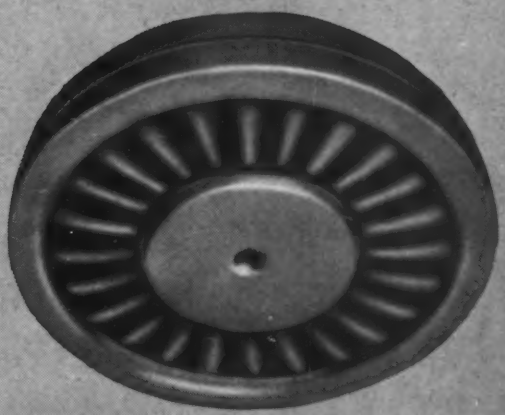
750-264C-1580

**Buy all the BONDS you can**
***—and keep all you buy***

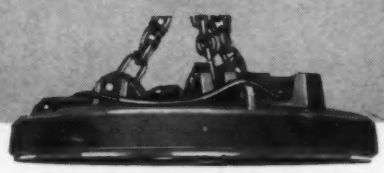
# A NEW E&M ALL-WELDED CIRCULAR LIFTING MAGNET



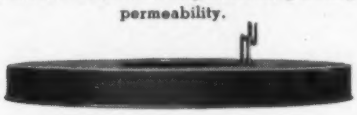
Streamlined design—nothing to catch on car sides.



Bottom view showing heavy pole shoes welded securely in place.



Special low-carbon steel magnet-housing having high permeability.



Continuous welds at the outer and inner edges seal the coil-case into the magnet-housing.

Heavy ribs strengthen plate and absorb blows due to impact when magnet is dropped on stockpile.

Center pole of wear-resisting, high-permeable steel, accurately machined for snug fit with magnet-housing. Outer pole-shoe ring of tough steel having both wear-resisting and high permeability qualities.

## *THIS ADVANCED DESIGN OFFERS IMPORTANT ADVANTAGES:*

**GREATER LIFTING CAPACITY** because (1) elimination of outer pole shoe bolt-recesses permits *full diameter coil* and (2) welding insures *permanent contact* between magnet-housing and the pole shoes.

**PROTECTION AGAINST MOISTURE** getting into the magnet-winding because it is *hermetically sealed by continuous welds.* Suitable for underwater salvage work—in cooling pits—and other applications where moisture is excessive.

**HIGH TEMPERATURE INSULATION.** All sizes of this SW Magnet use strap copper wound on a mica-insulated spool. The insulation between turns is asbestos tape impregnated with a new *thermo-setting compound—No. 282.* The coil, in its metal-enclosed case, is also filled with No. 282 and baked to set the compound. In this form, No. 282 does not melt, yet is resilient.

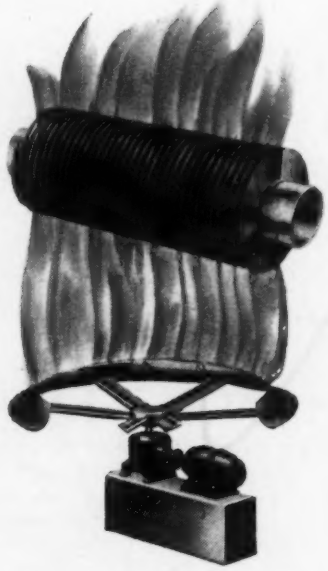
Write for booklet 900, giving complete description.

*The* ELECTRIC CONTROLLER & MANUFACTURING CO.

2698 E. 79th ST. CLEVELAND 4, OHIO

# COLD WEATHER DOESN'T PUT THE FIN FAN OUT OF BUSINESS

Sub-zero weather presents no problem with FIN • FAN operation because it uses *air* as the cooling agent. This makes the FIN • FAN Cooling Unit of particular value to those industries whose heat loads are heaviest during the winter months. Variable pitch fans with multi-speed drives can be adjusted to meet any changes in weather or load within design limits. This means substantial power savings, especially in cold weather... and economical operation the year 'round.



*FIN • FAN Cooling Units are produced and sold by: The Griscom-Russell Co. and The Fluor Corporation, Ltd.*

BE SURE WITH FLUOR SINCE 1890

# FLUOR

**ENGINEERS • MANUFACTURERS • CONSTRUCTORS**

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa, Boston

WORLD'S LARGEST

# ingot chariot

BUILT BY ALLIANCE...

ARMY E NAVY

The new Alliance Ingot Chariot in dumped position.

This Alliance Ingot Chariot is designed to convey 60 ton ingots from the soaking pits to the world's largest plate mill located at Lukens Steel Company, Coatesville, Penna.

The chariot, equipped with motor-drive longitudinal motion, is designed for fast operation with finger-tip control.

Individual motors drive the rolls and additional motors furnish power for the tilting pot. The motor-driven 6-finger pusher facilitates the pushing of short ingots on to the rolls, through the six square holes in the bottom of the tilting pot.

Alliance, world's largest builders of the world's largest cranes, recently announced a new soaking pit crane equipped with multiple range tongs and a hollow, rectangular, telescopic stiff leg.

A slab ingot ready for the approach table.

*Check with*

**Alliance**

*on new cranes or reconverting old cranes to give your plants more lifting power.*

THE ALLIANCE MACHINE COMPANY · ALLIANCE, OHIO

PITTSBURGH OFFICE: 1622 OLIVER BUILDING

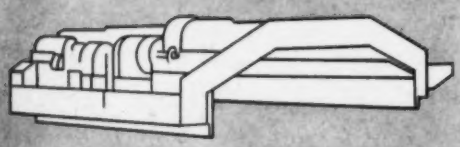
# Substantial Savings in cost *in every ton . . .* with

# SALEM CIRCULAR PITS

* *You can prepare ingots faster, and you have less trouble in the entire operation than with any other type pit. I would like to have all Salem Circular Pits in our plants. Our records prove that we make substantial savings on each ton of steel prepared in our 20′ Salem Circular Pit. . . .*

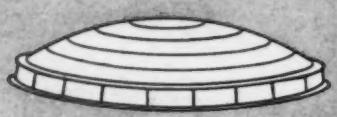
**Superintendent of one of America's largest mills.*

## SPECIAL COVER CRANE



Special Cover Crane . . . Toggle type lifting mechanism raises cover out of sand seal and transverse drive unit moves cover to either side. One crane can serve as many as five pits.

## BEST COVER ON ANY PIT



Best Cover on Any Pit . . . Less spalling because the cover dissipates heat slowly when off the pit.

Salem builds Circular Pits in diameters between 8′ and 20′ utilizing any conventional fuel.

Salem Specializes in Engineered Heat for Circular Soaking Pits, and all sizes and types of Heating Furnaces.

***"Send your heating inquiry to SALEM"***

## NO CHECKERWORK

No Checkerwork . . . The Salem Circular Pit has no expensive arches or checkerwork to replace.

## FAST HEATING TIME

Fast Heating Time . . . Heat is applied to the bottom of the ingot where it can be absorbed in a minimum of time.

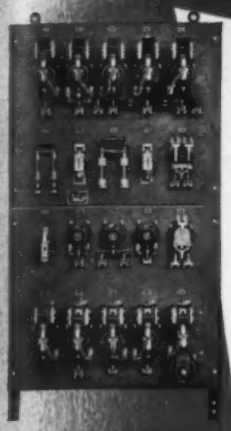
## MULTIPLE BURNERS

Multiple Burners . . . By using multiple burners, the heat diffusion through a furnace can be almost perfect. Multiple burners, equally spaced around the circumference, give a perfectly balanced heat treating furnace for ingots.

# SALEM ENGINEERING CO. · SALEM, OHIO

*"Engineered Heat"*

# RESEARCH "BUILDS IN" BETTER PERFORMANCE



Bulletin 9135—Crane Hoist Controller

Bulletin 9136—Crane Bridge and Trolley Controller

Experimental Hoist—for development of "3C" Control on AC and DC Motor Drives

Nothing is so perfect that it cannot be improved. No. 2 Atomic Bomb was better than No. 1.

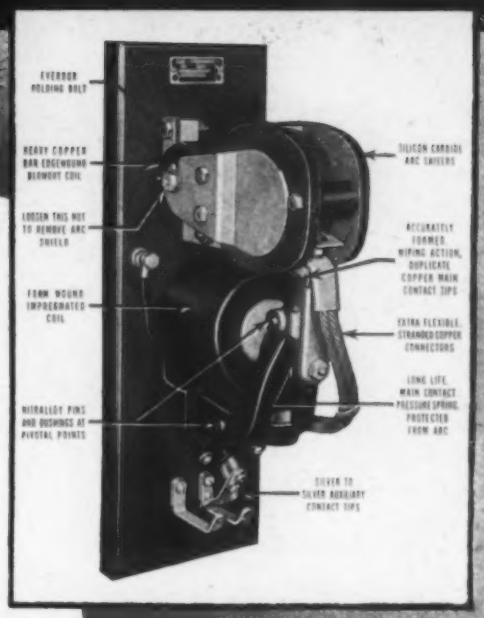
That's the constant aim at The Clark Controller Co.—to improve apparatus for better performance and "build in" low maintenance.

Thus in D. C. Crane Control, the experimental Testing Hoist shown at lower left, gives factual proof of "3C" Bulletin 9135 Crane Hoist Controller operation. Inching, spot lowering, loaded and empty hook capacity can be readily observed.

The heart of this control is the "3C" Bulletin 7400 Contactor. To record its performance, high speed motion pictures (3000 per minute) have been taken of it in operation. An ingenious spotlight records on the edge of the film the split second action of this contactor. By counting the number of spotlight flashes it is simple to figure accurately the time required to close and open the contacts, the size and duration of the arc, how the arc is extinguished, and other functions which cannot be seen directly. By projecting the film at regular speed, otherwise unavailable data is made clearly apparent.

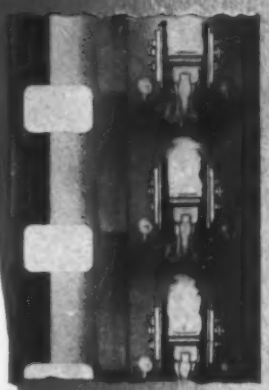
These and other tests provide visible evidence which make "Built-in" low maintenance and dependability possible.

*Ask for D-B 9100-1 "3C" Crane Control Booklet.*



Bulletin 7400 Type RD Contactor

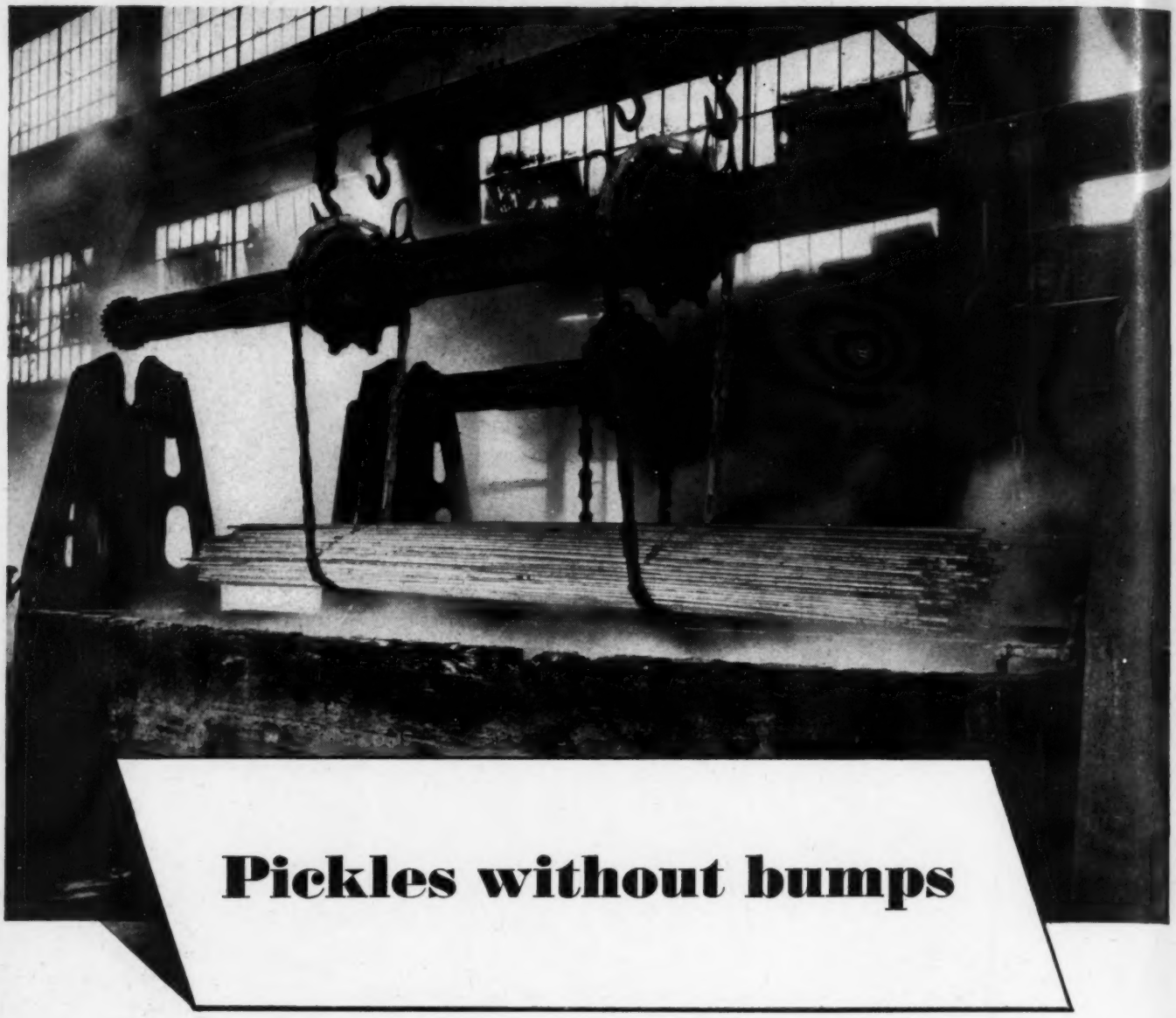
Side view—Contacts open. Arc at Maximum



Front view—Contacts open. Arc at Maximum

**THE CLARK CONTROLLER CO.**

1146 EAST 152nd ST., CLEVELAND 10, OHIO • EVERYTHING UNDER CONTROL



# Pickles without bumps

Mechanical picklers for light-walled tubing need a special kind of chain.

That's because light-walled tubing collapses as it rolls and bumps against the links of *ordinary* pickling chains.

Specially designed chains, made by *The Youngstown Welding & Engineering Company,* Youngstown, O., fixed everything nicely for one Pennsylvania tube mill. Each link level with the next one. No bumps to cave in the tube walls.

Fabricated from standard mill forms of Monel* flat bar, the chains consist of alternate open and closed links joined by 1″-diameter Monel pins. Lighter in weight than chains previously used, these cost less, for they last just about *four times* as long.

When the pickling operation is completed, shaft, chains and four-ton tubing load are picked up and swung to an unloading rack. The chains, in addition to being strong and corrosion-resistant, must be *safe.*

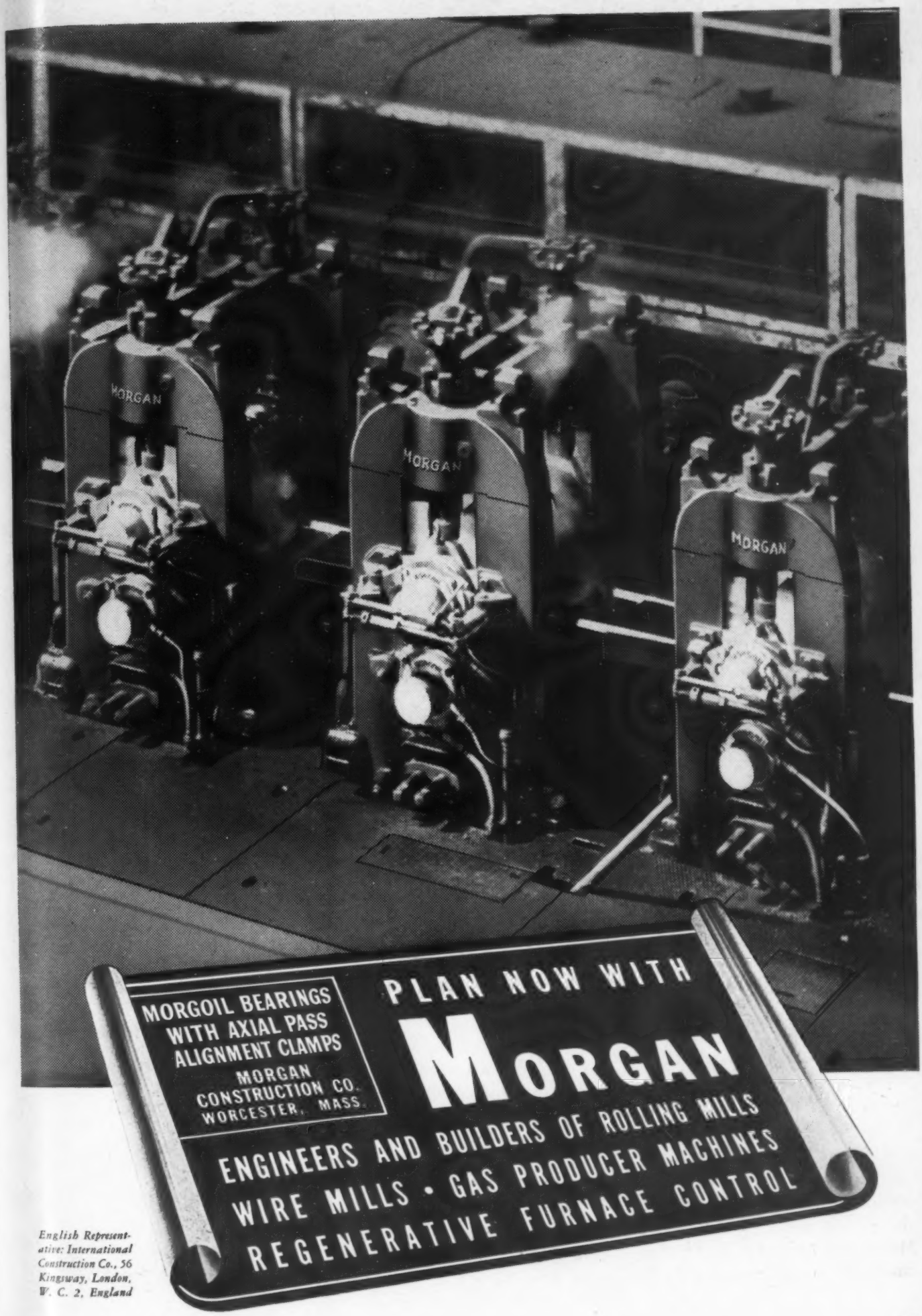
*The Youngstown Welding & Engineering Company* knew that Monel's high strength and excellent resistance to commonly used pickling acids made it unnecessary to pile on weight to get strength, or to allow for loss of strength due to rapid corrosion.

Another factor leading to selection of Monel was its availability in all usual mill forms. These could be readily fabricated to whatever shapes were needed, and then welded by any commonly used method. (When designs call for stamping, drawing, forging or machining, these operations also are easily accomplished.)

Monel has *many* applications in pickling. And it's quite likely that properly designed Monel equipment can bring safety and smooth-running efficiency to a tough job in *your* pickling department, too. Write us for further information. *The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.*

*Reg. U. S. Pat. Off.

**Monel**




*English Representative: International Construction Co., 56 Kingsway, London, W. C. 2, England*

# CARBON HAS NO MELTING POINT!

CARBON, in all forms, volatilizes without melting at temperatures far above those encountered in commercial operations.

The use of large carbon blocks for blast furnace linings is an excellent example of carbon's extraordinary ability to retain its shape—*and strength under pressure*—at white hot temperatures. In addition, it is highly resistant to chemical attack by the most corrosive slags. Hence it has become the preferred material for many high temperature applications in the metallurgical and electrochemical fields.

Graphite's very low coefficient of thermal expansion—.0000015 per °F—explains why some graphite molds for ferrous and non-ferrous metals withstand several thousand pours without longitudinal or cross-sectional change. Graphite electronic tube components, at temperatures far exceeding operational requirements, maintain an unmatched degree of dimensional stability.

Furthermore, "National" Carbon and Graphite are available as porous materials or in the form of "Karbate" impervious products for the chemical industries. We invite your inquiries on the many applications and installations of these highly versatile materials of construction.

**BAR OF WHAT?**

Carbon, Graphite or "Karbate" materials, of course!

The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

**NATIONAL CARBON COMPANY, INC.**

*Unit of Union Carbide and Carbon Corporation*

UCC

*General Offices:* 30 East 42nd Street, New York 17, N. Y.

*Division Sales Offices:* Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

# WILSON Rectangular Bell Type Furnaces for Steel Coil Annealing

One installation of 42 Furnaces and 126 Bases used exclusively for annealing tin plate coils.

For maximum flexibility in production — a 4-stack unit.

THE Lee Wilson Engineering Company is ready for the new expansion in the strip sheet and tin plate industry.

New developments in the use of radiant tube and convection heating will increase the tons per hour yield in annealing furnaces designed for larger coil diameters and increased piling heights.

The Wilson Annealing Unit is covered by Patents Nos. 1,952,402, 2,068,477, 2,078,356, 2,081,612, 2,089,843, and other patents pending.

ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson ENGINEERING Co., Inc.

20005 West Lake Road CLEVELAND, OHIO

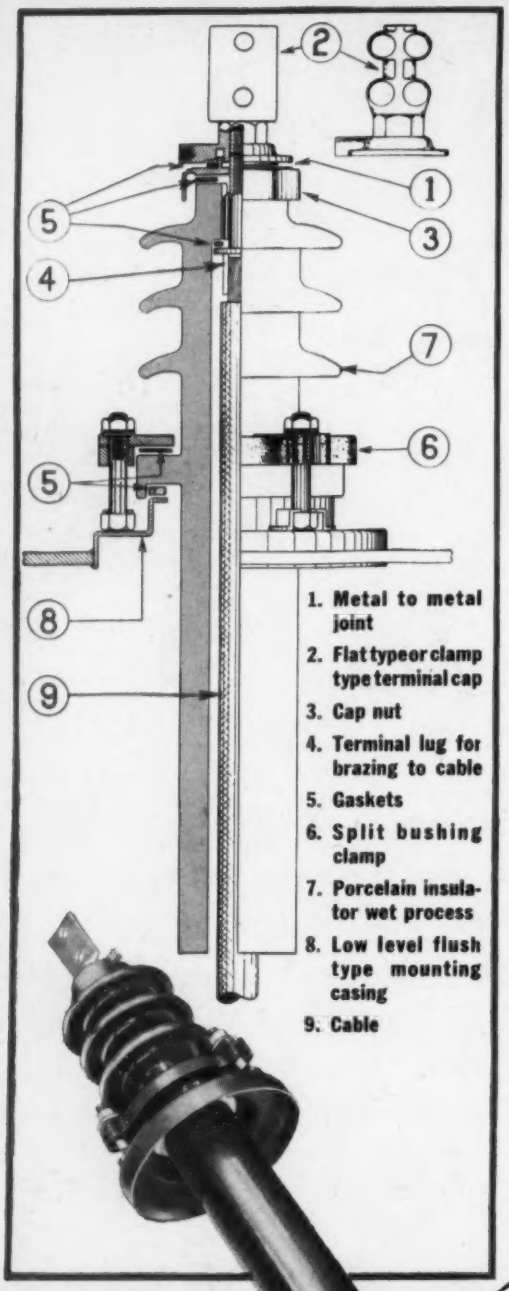
Telephone ACademy 4670

Sold by The WEAN ENGINEERING CO., Inc., Warren, Ohio

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

# NEW Pennsylvania CLAMP-TYPE TRANSFORMER BUSHINGS are LEAKPROOF

**ALL METAL PARTS ARE CLAMPED TO THE PORCELAIN WITHOUT THE USE OF CEMENT!**


1. Metal to metal joint
2. Flat type or clamp type terminal cap
3. Cap nut
4. Terminal lug for brazing to cable
5. Gaskets
6. Split bushing clamp
7. Porcelain insulator wet process
8. Low level flush type mounting casing
9. Cable

## PENNSYLVANIA POWER BUSHINGS

***Voltage Rating: 7,500, 15,000, 25,000 and 34,500 Volts***

***Current Rating: 440 Amperes***

Made of wet process porcelain, *all metal parts are clamped to the porcelain insulator without the use of cement.* This applies to the conductor as well as to the flange which bolts the bushing to the mounting casing. The *elimination of cement* facilitates replacement of the insulator and *assures oil-tight and gas-tight joints.*

The cable lead from the transformer winding is brazed to a stud which issues through the insulator in a manner that prevents it from turning when the hardware is attached.

Electrical and mechanical connections between the stud and the hardware at the top of the porcelain are made by a cap nut tightened against the porcelain through a cork gasket, and a terminal cap on the same stud, tightened against the cap nut. This metal to metal contact assures permanent pressure on the threads of the stud and provides a positive high pressure and low resistance contact. Either a spade-type terminal for bus connection, or a cable clamp-type terminal may be used. Both types are interchangeable.

Bushings are bolted to the mounting casing by means of a split flange which rests on the top of the porcelain shoulder. Between the shoulder and the transformer cover, there is a gasket which provides an oil and gas-tight seal.

*The new, improved, clamp-type transformer bushings described above are the result of Pennsylvania's constant research and endeavor to impart greater reliability and longer service life to transformers.*

Pennsylvania TRANSFORMER COMPANY
808 Ridge Avenue, N. S., Pittsburgh 12, Pa.

Pennsylvania TRANSFORMERS

# COLD NOSES . . . A SIGN OF HEALTH FOR BOSH PLATES ALSO

**N•B•M Nose-Cooled Plates Last 5 Times Longer —Guard Furnace Linings from Water Leaks**

Ordinary single-compartment bosh and mantle plates are highly vulnerable to fire cracks and damaging leaks. N-B-M double-compartment plates deliver cold water directly to the nose at high velocity. Result: Rapid cooling • Far longer life • No accumulation of sediment • If nose does crack, the second compartment can still be used for cooling.

We furnish these Model "D" plates complete with pipes, ready to install. Place these in service—alongside conventional plates—and let them *prove* their worth.

**N • B • M**

**BRONZE AND COPPER CASTINGS**

**Blast Furnace Copper Castings • Roll Neck Bearings • Slippers • Housing Nuts • Machinery Castings • Babbitt Metals • Acid Resisting Castings Phosphorized Copper**

NBM

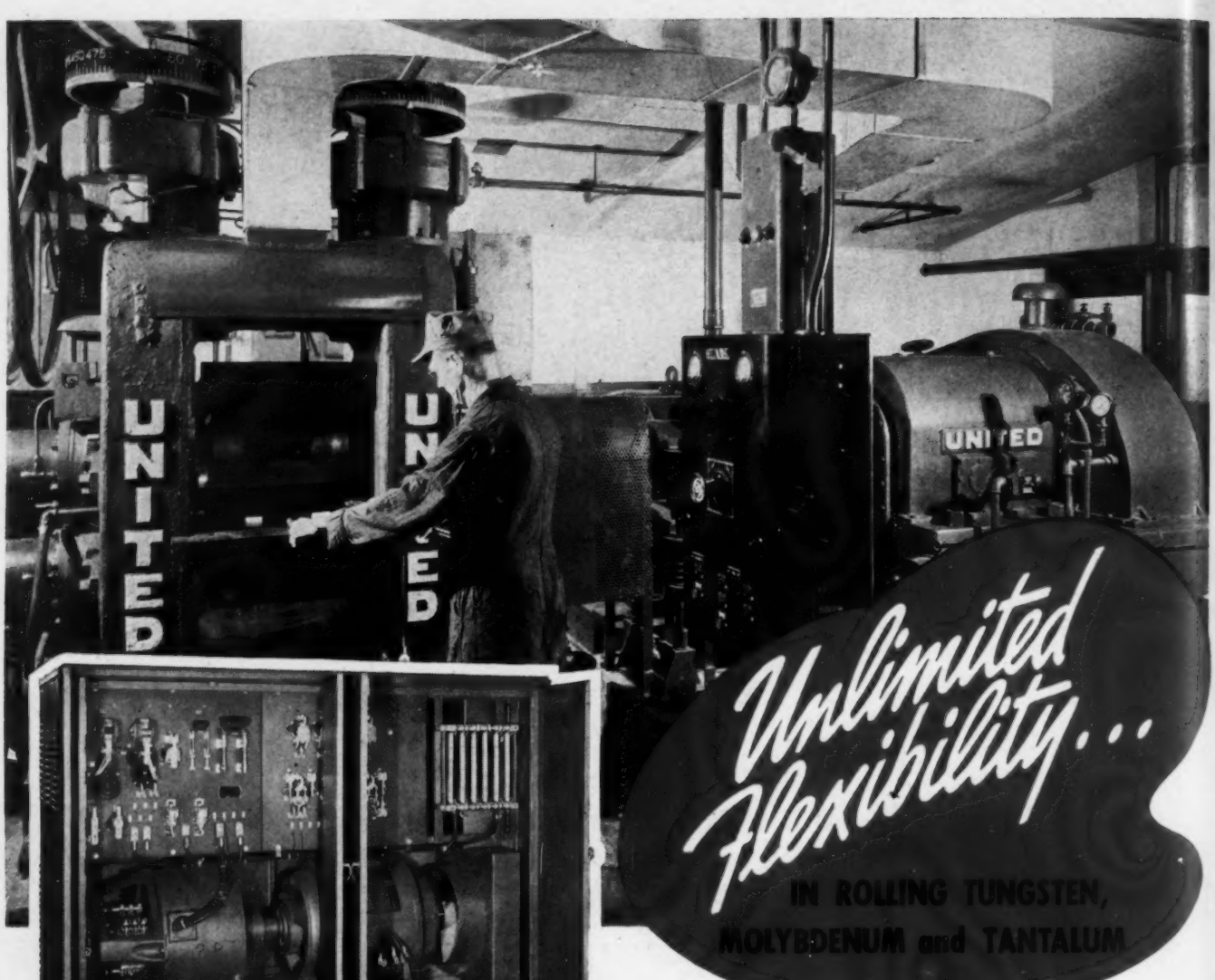
**NATIONAL BEARING**

**DIVISION**

PITTSBURGH NEW YORK

AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.




*(Left) Control Unit for the 100 Hp. Reliance V★S Drive, operating from the plant's A-c. circuit, provides infinite speed adjustments for the United 12" Two-High Hot Breakdown Mill shown above.*

There was an important reason for the choice of Reliance V★S Drive to operate the specially designed hot breakdown mill in the North Chicago, Illinois, plant of the Fansteel Metallurgical Corporation. This was because, with V★S control, unlimited flexibility of operation is available for widely varied working requirements.

The mill can be adjusted easily and quickly for any desired process and speed can be changed at will to suit the material and the requirements of the job.

Whenever such flexibility is desirable, it can be obtained—without clutches or gears—by the use of V★S Drive. V★S is an *all-electric adjustable-speed drive, operating from A-c. circuits.* Starting, stopping and speed changes are controlled from nearby or remote stations. Automatic reversal is available at any desired point.

For information on how Reliance V★S Drive may help you to speed production and cut costs, call the nearest Reliance office or write for Bulletin 311.

**RELIANCE ELECTRIC & ENGINEERING CO.**
**1084 IVANHOE ROAD • CLEVELAND 10, OHIO**

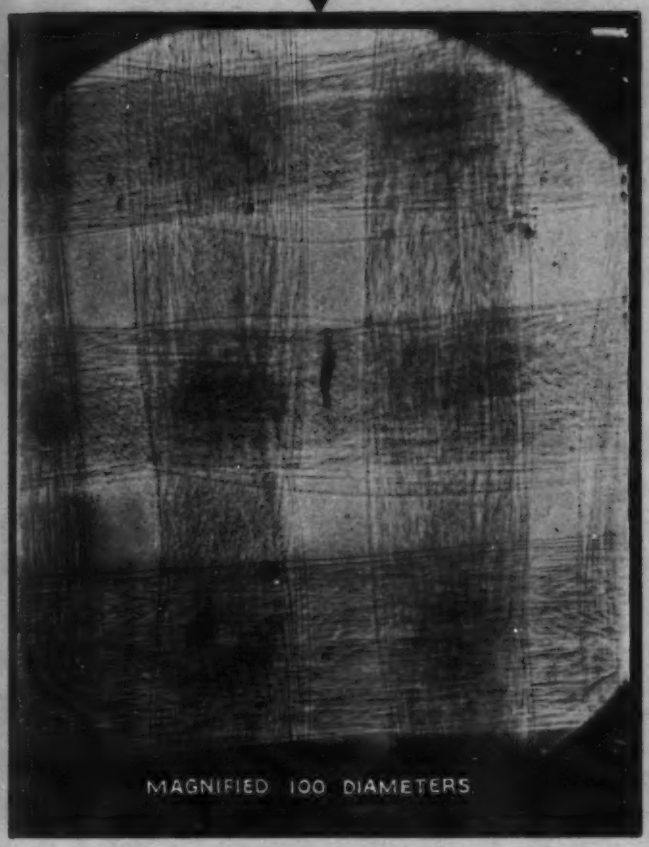
Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit
Greenville • Houston • Kalamazoo • Knoxville • Los Angeles • Minneapolis
New Orleans • New York • Philadelphia • Pittsburgh • Portland, Ore. • Rockford, Ill.
St. Louis • San Francisco • Seattle • Syracuse • Washington, D. C.

"MOTOR-DRIVE IS MORE THAN POWER"

**RELIANCE A-C D-C MOTORS**

# ELECTRO-TECHNICAL ANNOUNCES A NEW PRE-TREATMENT PROCESS FOR CLASS "B" INSULATION FABRICS

- ✓ UNIFORM DIELECTRIC VALUES
- ✓ HIGHER MOISTURE RESISTANCE
- ✓ EASIER WINDING APPLICATION
- ✓ GREATER MECHANICAL STRENGTH




**ELECTRO-TECHNICAL PRE-TREATMENT VARNISHED *FIBERGLAS CLOTH**

This new pre-treatment process developed in the Modern Textile Laboratories of ELECTRO-TECHNICAL • enables varnish to penetrate and disperse air around and between filaments at intersections of warp and filler yarns.

This process also renders the cloth more pliable and soft • and susceptibility to cracking after folding over itself has been eliminated.

**ORDINARY VARNISHED *FIBERGLAS CLOTH**

Notice the heavy presence of air pockets and untreated fibers thru out the fabric structure • and especially at intersections of warp and filler yarns.

Non pliable fabrics are more difficult to handle during winding operations.

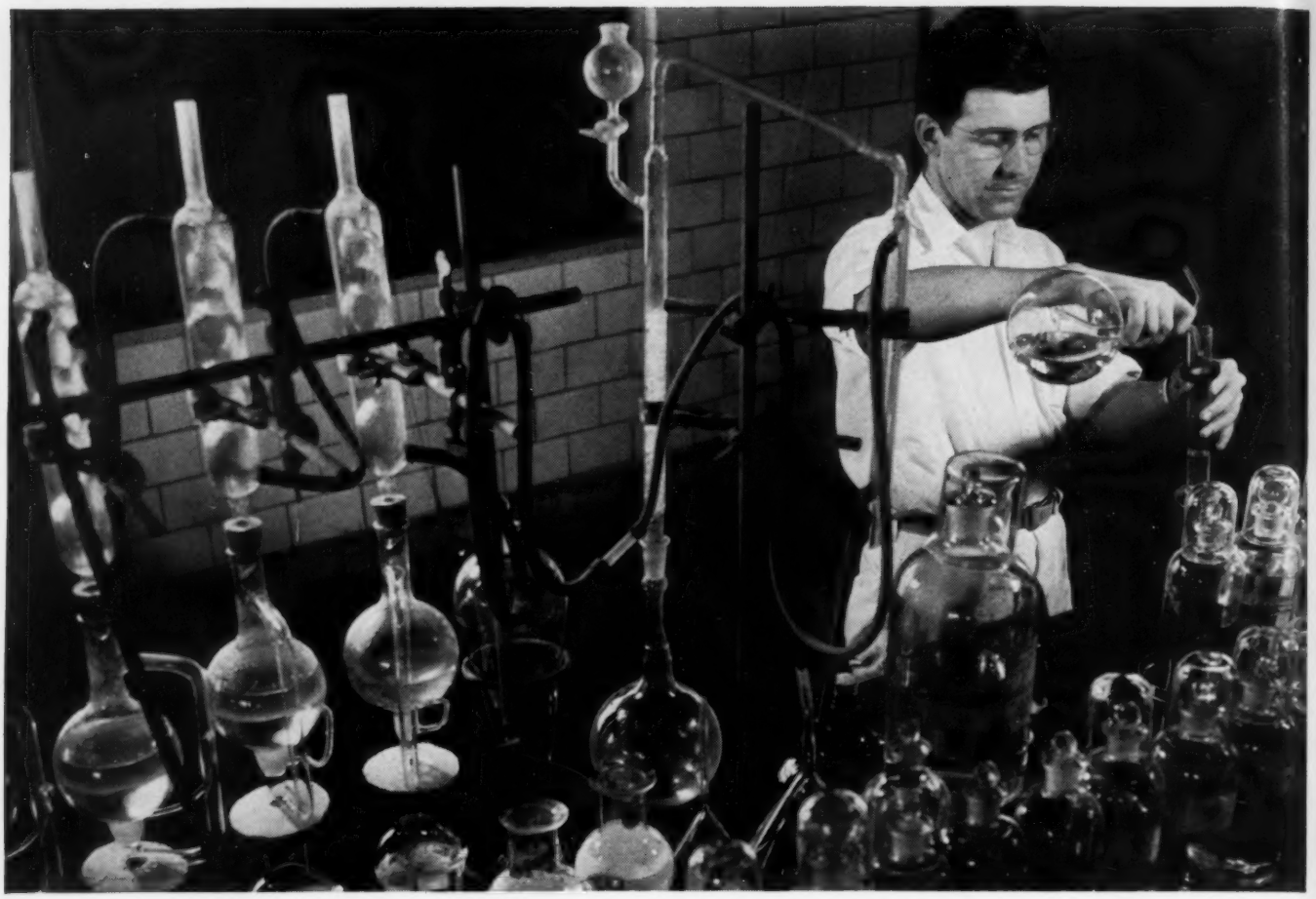
**ELECTRO-TECHNICAL PRODUCTS, INC.**

**ELECTRICAL INSULATION DIVISION**

**115 CENTRE STREET, NUTLEY 10, N.J.**



* T.M. Reg.—Owens Corning Fiberglas Corp.



# WHERE THE *Nth* DEGREE IS NOT ENOUGH

## The Chemical Industry Demands Absolute Accuracy...
## BOWSER LIQUID CONTROL PROVIDES IT

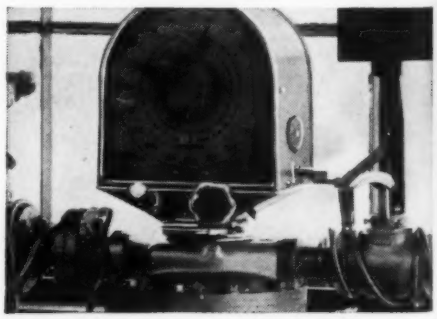
Infinite care must be exercised in the manufacture of chemicals. Every drop, every particle of every element must be measured, counted, weighed. The finished product must check exactly with the equation. Public health is often at stake. There can be no margin for error.

Precision equipment is a must. That's why you'll find many Bowser Automatic Xacto Meters used by the Monsanto Chemical Co., one of the nation's largest and best known manufacturers of chemicals for industry and the home.

Bowser Xacto Meters are as simple to operate as they are accurate. The quantity predetermining mechanism, with which they can be equipped, assures delivery of the *exact* amount of the liquid desired. There's no chance for error. Bowser Automatic Xacto Meters save time, save labor, save money, prevent waste. And remember, there are many types of Bowser meters and dials for handling a wide variety of liquids.

**In the steel industry, too, Bowser Liquid Control equipment is considered indispensable. Bowser lubrication for mill stands, reduction gears, pinion gear sets, turbines, etc., has been adopted for 90 per cent or more of all steel production in the United States. Bowser meters for fuel oil and Bowser coolant systems are also widely used.**

**Bowser installations are "tailor made" to be integral parts of the mill. A Bowser engineer will be glad to consult with you. Write BOWSER, INC., Dept. 13-J, Fort Wayne 2, Ind.**

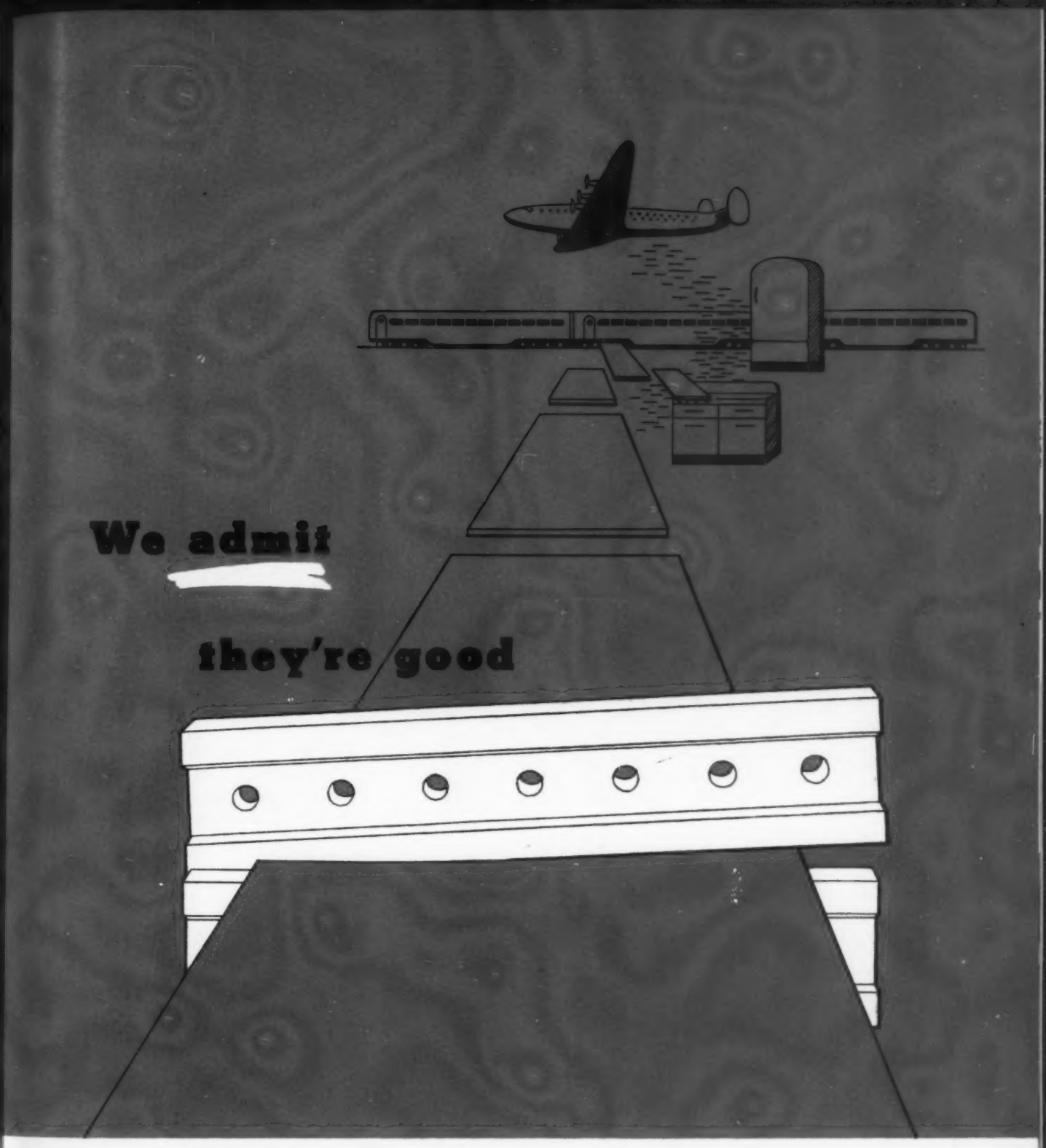


**One of the Bowser Automatic Xacto Meters in the St. Louis plant of Monsanto Chemical Company**

**BOWSER**
**SINCE 1885**

**THE NAME THAT MEANS EXACT CONTROL OF LIQUIDS**

**Not only has Bowser's war production earned the Army-Navy E... Bowser equipment has helped earn it for scores of other companies.**




*Heppenstall Shear Knives*

have proved their ability

to do more work and a

better job at a lower cost

It's easy to *talk* a good shear knife and build a story around how well they're made BUT, cold records of actual shear knife service in a man's *own* mill—that's all that means much *to him*. That defies argument . . . That's the *only* evidence that we ask you to believe—that Heppenstall Shear Knives, over a 50 year period, under various closely competitive conditions, have delivered more and cleaner cuts per grind and per dollar of original cost. So, we feel safe in saying that they will reduce *your* shearing costs *substantially*. Write for quotation. Heppenstall Co., Pittsburgh, Pa.

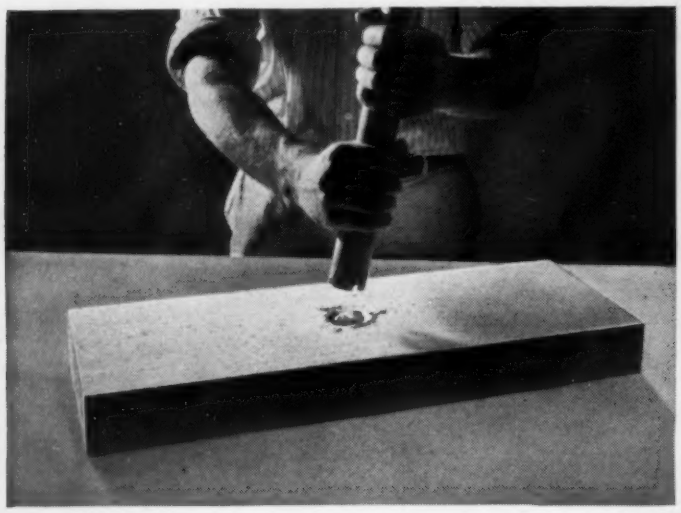
**Heppenstall**

*the most dependable name in forgings*

*Right on the job...*

# J-M INSULATING FIREBLOK

*is EASY to work!*



YOU can saw, rasp or drill Johns-Manville Insulating Fireblok in little time, with simple tools. Shape and fit it into irregular spaces. Eliminate large inventories of special sizes . . . *and speed installation.*

Johns-Manville Insulating Fireblok offers *all* these advantages:

**Exceptionally light weight:** Each J-M Insulating Fireblok, though over five times as large, weighs little more than one ordinary fire brick!

**Speedier assembly:** This lightness . . . coupled with extra size . . . enables Fireblok to be installed more quickly thus cutting expensive furnace downtime and lowering labor cost.

**Economical Bonding:** Fewer joints make a substantial cut in the amount of cement needed for bonding. (J-M 1626 cement was developed especially for this purpose.)

**Fewer joints cut heat loss:** The broader, uninterrupted surfaces of large-size Fireblok increase the thermal efficiency of the construction.

**Variety of uses:** Particularly recommended for industrial furnaces, flues, stacks, etc. Also, for lining doors, suspended arches, and when tapered, for sprung arches of exceptional stability.

**Specific temperature ranges:** Large-size J-M Fireblok—like small-size J-M Insulating Fire Brick—come in four different types . . . each especially developed for its particular temperature range.

**Part of a team:** Fireblok is but one of many J-M industrial insulations. Like the others, it represents years of research—experience that can help you in your insulation planning. For further information, write Johns-Manville, 22 E. 40th St., New York 16, N. Y.

**Installing J-M Fireblok** on a suspended arch-type furnace, using convenient J-M hanger supports. Despite the large size of Fireblok, it is light in weight . . . easily handled.

**4 Types Available:**

JM-1620 Fireblok for exposed temp. to 1600°F. As back-up to 2000°F.

JM-20 Fireblok for use up to 2000°F. Exposed or back-up.

JM-23 Fireblok for use up to 2300°F. Exposed or back-up.

JM-26 Fireblok for use up to 2600°F. Exposed or back-up.

# JOHNS-MANVILLE *First in* INSULATIONS

# "It's Steel!"

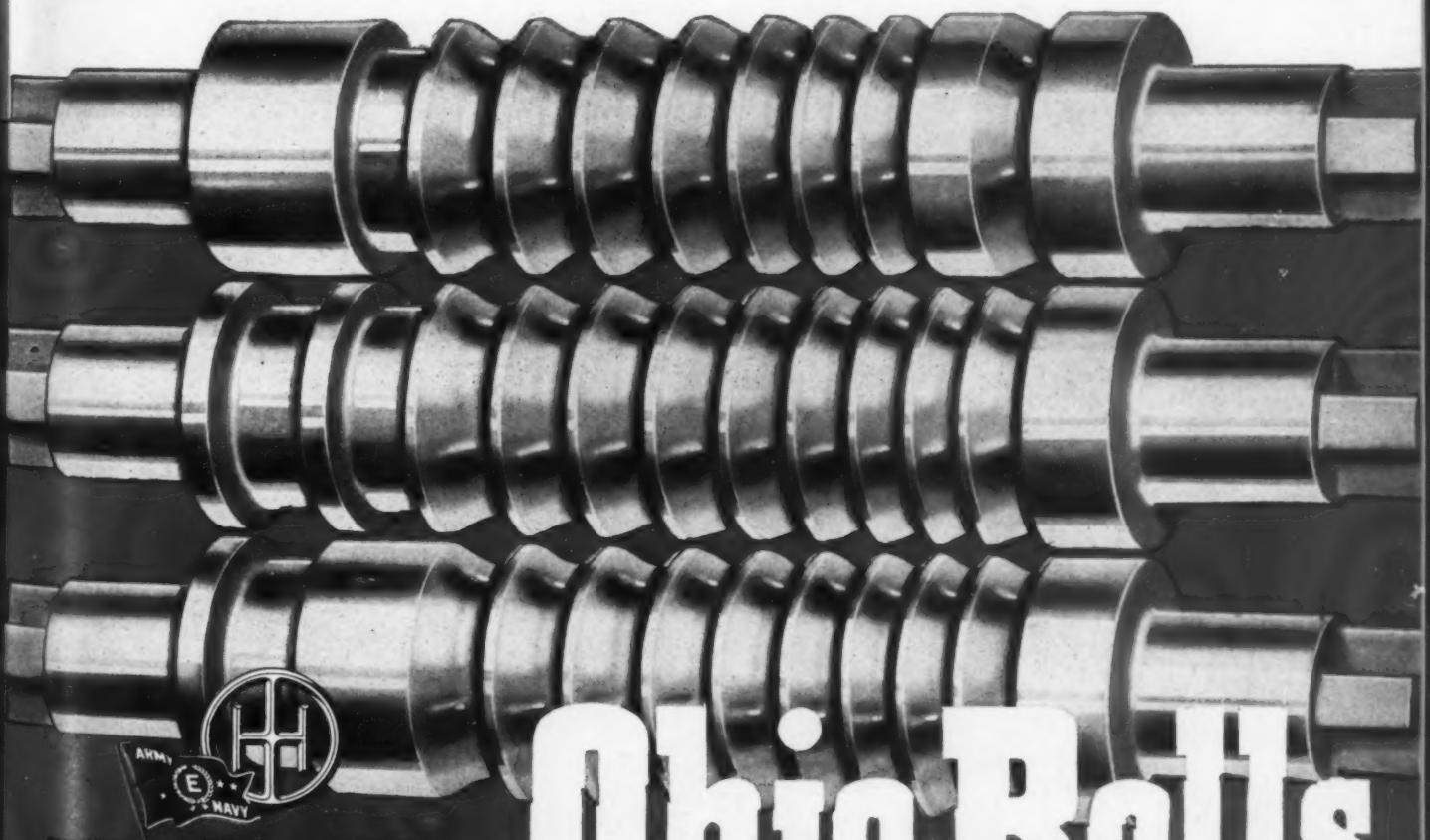
**What more is there to say?**

Unqualified, the merits of steel have been proved in thousands of applications, from steam shovels to washing machines.

The net result is a market that is waiting impatiently for articles made from steel—and they'll accept no substitute.

Logically, then, steel must be produced in quantities never before paralleled in the history of peacetime production.

Obviously, rolls will also be needed in proportion to this demand. It is Ohio Steel's intention to produce these rolls—*right* and in a minimum of time.



ARMY E NAVY

PATTERNERS · FOUNDERS · MACHINISTS

Select from any of these 9 types of Ohio Steel and Iron Rolls: Carbon Steel Rolls • Ohioloy Rolls • Ohioloy "K" Rolls • HOLL-O-CAST Rolls Chilled Iron Rolls • Dense Iron Rolls • Nickel Grain Rolls • Hi-nickel Grain Rolls • Flintuff Rolls

# Ohio Rolls

THE OHIO STEEL FOUNDRY COMPANY

LIMA, OHIO • PLANTS: LIMA AND SPRINGFIELD, OHIO

1945

# Airco Processes Help

**Flame Scarfing** with Airco heavy duty scarfing torches gives billets, slabs and blooms a quick conditioning prior to rolling.

MORE and more the steel industry is using Airco performance-proved oxyacetylene flame and electric arc methods for production speed, economy and flexibility. These versatile modern "tools" provide valuable aid in many ways—by speedily cutting up scrap and ladle skulls for charging, cropping ingot hot tops and bottoms, oxygen lancing, flame cutting and electric welding for maintenance and new construction.

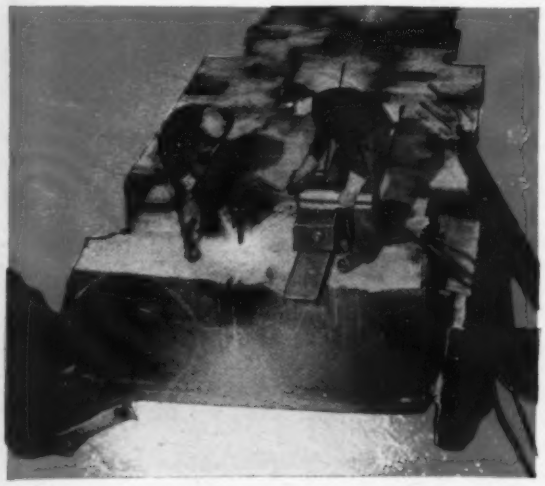
The illustrations on these pages show just a few of the many Airco processes widely used by the steel industry. For helpful technical information in applying these processes to your particular problem—write Airco's Applied Engineering Department. Address your nearest Air Reduction office, or Dept. IS in New York.

AIRCO

# Speed Steel Production

**Electric Arc Welding** quickly fabricates a buck stay for an open-hearth furnace to replace a burned-out stay.

**Flame Cutting** by hand saves valuable time on many jobs. It is widely used by industry to quickly trim plate to size; for making replacement parts, dismantling and many other production, maintenance and salvage jobs.



**Machine Gas Cutting** opens the way to important savings of production time and cost when cutting heavy slabs, ingots and many other large, thick sections. The Airco Heavy Duty Radiagraph shown here is especially designed for flame cutting very heavy sections (20" to more than 40") from carbon and alloy steels.

**Oxyacetylene Welding** speedily repairs an open-hearth furnace door frame, worn thin in normal service. Weak spots are strengthened by patches welded into place with the hand torch.

**Braze Welding** (building up with bronze metal) restores innumerable worn or damaged parts to service quickly—with minimum interruption to production. An effective method of making repairs—often without dismantling equipment.

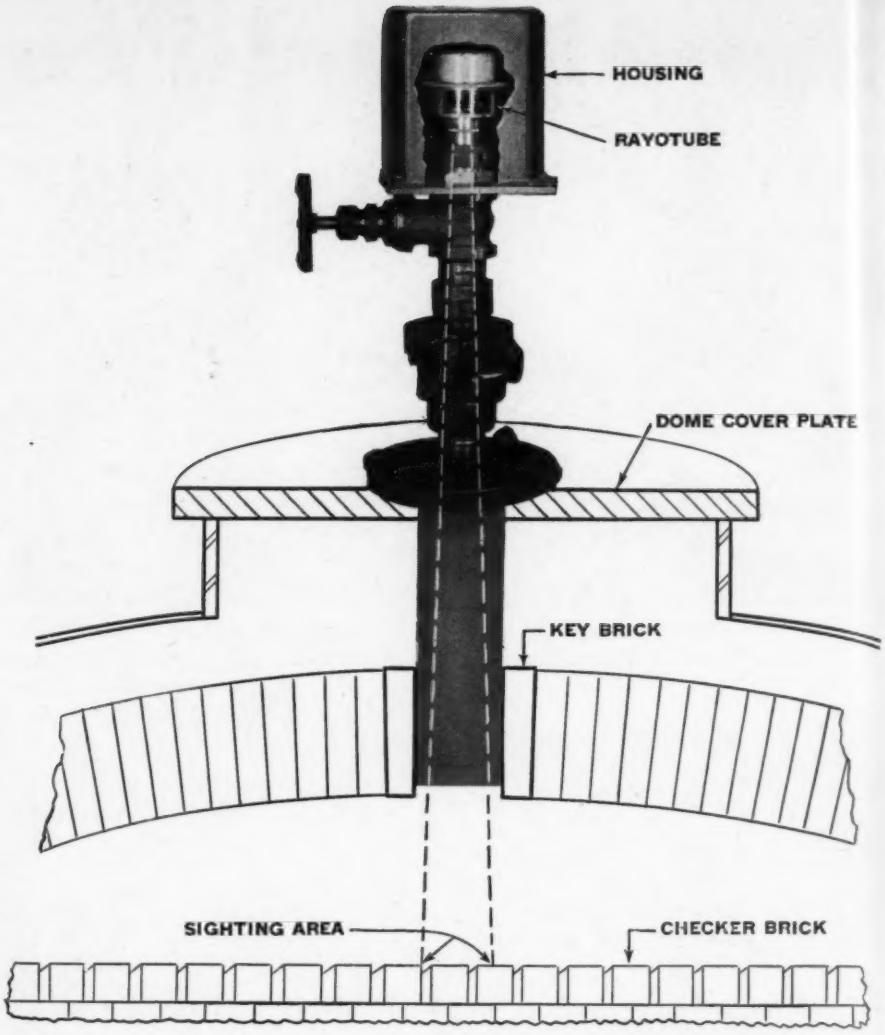

**AIR REDUCTION**

[illegible] 42nd STREET, NEW YORK 17, N.Y.

In Texas: MAGNOLIA AIRCO GAS PRODUCTS CO. • General Offices: HOUSTON 1, TEXAS

*Offices in all Principal Cities*

Represented internationally by Airco Export Corporation




A new blast furnace idea: Rayotube installed to detect the temperature in the dome of a blast furnace's stove. Temperature is charted by a Micromax Recorder in the blast furnace control room.

# FURNACE OPERATIONS BEING IMPROVED

## By New Uses of RAYOTUBES

The radiation-catching Rayotube, remarkably sensitive yet sturdy, is getting a vote of confidence from many blast-furnace engineers for its job of detecting the temperatures of blast-furnace stove domes. Together with its convenient Micromax Recorder, it has, in the last two or three years, been installed with approved results on more than 70 stoves.

For this work Rayotube tops the performance of the widely-used Thermocouple on several counts. Men using the Rayotube discover that it gives a more useful temperature reading, since it picks up temperature directly from the surface of the checker brick rather than from the blast gas. Guided by checker rather than gas temperature, the operator can prevent fusing of ash and damage to checkers, can avoid running the stove too hot, but yet can run it safely up to its maximum heat capacity.

Further in its favor, the Rayotube brings both replacements and maintenance to a minimum. Since it is located outside the furnace, away from both the heat and the destructive reducing atmosphere inside, the Rayotube need never burn out, as long as it gets normal routine care.

What Rayotubes have done to improve the accuracy of blast furnace temperature control, they can do for many other problems in the steel mill. Your specific inquiry will bring our recommendation, or the appropriate catalog, as you prefer.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-33B-642(1)

18" and 48" x 48" 5-Stand Tandem—4-High Cold Strip Mill

FOR PRODUCTION OF SHEET AND TINPLATE STOCK

UNITED ENGINEERING and FOUNDRY COMPANY, for 40 years leader in the development of cold reduction processes, offers immediately available designs for high speed, high production, 5-stand tandem tinplate mills with finishing speeds up to 5000 F.P.M. Also available are designs for modern 4-stand and 3-stand units.

These mills embody all the latest features in auxiliary equipment including uncoilers, guides, coolant systems, tension rolls, coilers, etc.

Consult UNITED'S engineers when making plans for reconversion and expansion.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

Subsidiary: Aluminum United Corporation, Akron, Ohio

Affiliates: Barry and United Engineering Company, Ltd., Sheffield, England

Dominion Engineering Works, Ltd., Montreal, P. Q., Canada

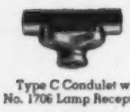
The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

# CROUSE-HINDS

# Industrial Lighting Fixtures

**The illustrations show a representative selection from the hundreds of different CROUSE-HINDS lighting fixtures—each designed for its own particular purpose.**

**No. 3**
of a series of advertisements which demonstrate that CROUSE-HINDS "complete line" means much more than just a range of sizes—there is a wide variety of highly specialized types in each classification.


Type C Condulet with No. 1706 Lamp Receptacle

Type GRF Watertight Pilot Light Condulet

Type FS Lighting Fixture *for flush mounting in walls to light steps, floors, walks and gardens*

Type FS Condulet with Pilot Light, Switch, and Lamp Receptacle

Type G Condulet with No. H556 Lamp Receptacle

Type EGP Explosion-Proof Pilot Light Condulet *for panel mounting*

Type GRF Condulet with Lamp Receptacle

Type GSC Condulet with Bracket Lighting Fixture

Type MB Two-Gang Watertight Marine Pilot Light Condulet

Type V Vaportight Lighting Condulet *for mounting on machines*

Type EFS Explosion-Proof Condulet with Double Pilot Light

Type GS Condulet with Shock-Absorbing Lamp Receptacle *for use on machinery*

Type VDA Vaportight Observation Light Condulet *for mounting in vats*

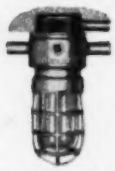
Type LMKB Lighting Condulet

Type LMG Lighting Condulet

Type WV Vaportight Lighting Condulet with Fresnel Lens

Type VPH Vaportight Indirect Lighting Condulet

Type VR Vaportight Lighting Condulet *for mounting on a hand rail*


Type VXJ Vaportight Lighting Condulet *for making extensions from concealed conduit wiring*

Type V Vaportight Heavy Duty Lighting Condulet with Shatterproof Globe *for use in the food industry*

Type C Condulet with Type ARC Vaportight Lighting Fixture

Type VXHA Vaportight Lighting Condulet with Flush Hubs

Type VDB Vaportight Lighting Fixture Condulet with Dome Reflector *500-Watt*

Type EVS Explosion-Proof Portable Lamp

Type RMC Watertight Marine Lighting Fixture

Type MLC Watertight Marine Lighting Condulet Shock-Absorbing Receptacle

Type MLC Watertight Marine Lighting Condulet

Type LPH Safety Hand Lamp

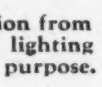
Type EVG Explosion Proof Lighting Condulet *for gasoline pumps*

Type DLA Dust-Tight Lighting Fixture Condulet with Flat Cone Reflector

Type VC Vaportight Lighting Fixture Condulet

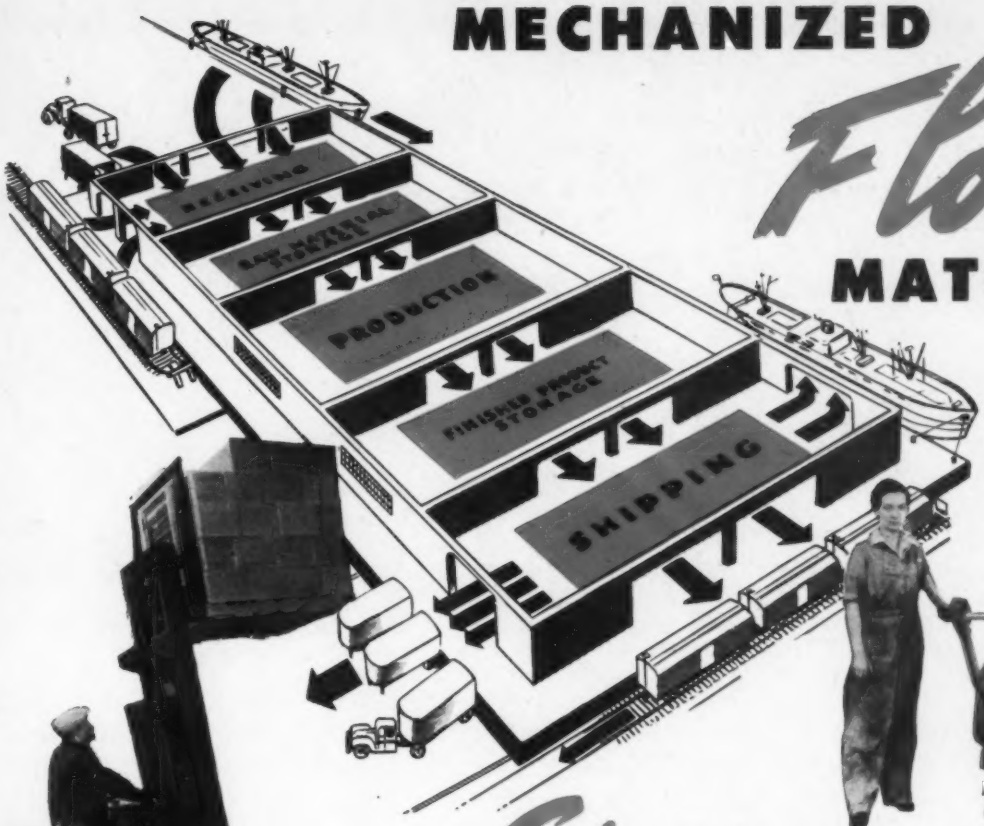
Type DLA Dust-Tight Lighting Fixture Condulet *500-Watt*

Type HNDS Condulet with Lighted Sign



Type EVA Explosion-Proof Pilot Light Condulet

# MECHANIZED *Flow* OF MATERIALS




AUTOMATIC TRANSPORTER MOTORIZED HAND TRUCK

AUTOMATIC FORK TRUCK

*Gives you*

## LOWER UNIT COSTS . . .

Management is now *compelled by competition* to utilize men, methods, materials and machines in a manner *to achieve lowest production cost and sales price per unit.*

While processing motions usually add value to a product, *handling motions add only to its cost.*

You can lower your unit costs if you will team up AUTOMATIC's battery-powered Fork Truck with the war-tested "TRANSPORTER," AUTOMATIC's *service-proved,* motorized hand truck,—and apply AUTOMATIC's Engineered Materials Handling Methods.

AUTOMATIC's completely Engineered Materials Handling Service will do these things for you:

1. *Eliminate* costly manual handling.
2. *Reduce damage* to materials handled.
3. *Increase storage capacity* by safe, vertical stacking of materials to rooftop.
4. *Simplify inventory* control.
5. *Increase productivity* by reducing labor fatigue.
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NO WONDER these Gargoyle Viscolite Fluids are called "Black Magic"! Here's the magic they work:

Containing a volatile, non-inflammable diluent, they flow like oil without the necessity of heating. Thus, they can be painted on with a brush, poured from a can or applied with drip-oilers or mechanical force-feed lubricators.

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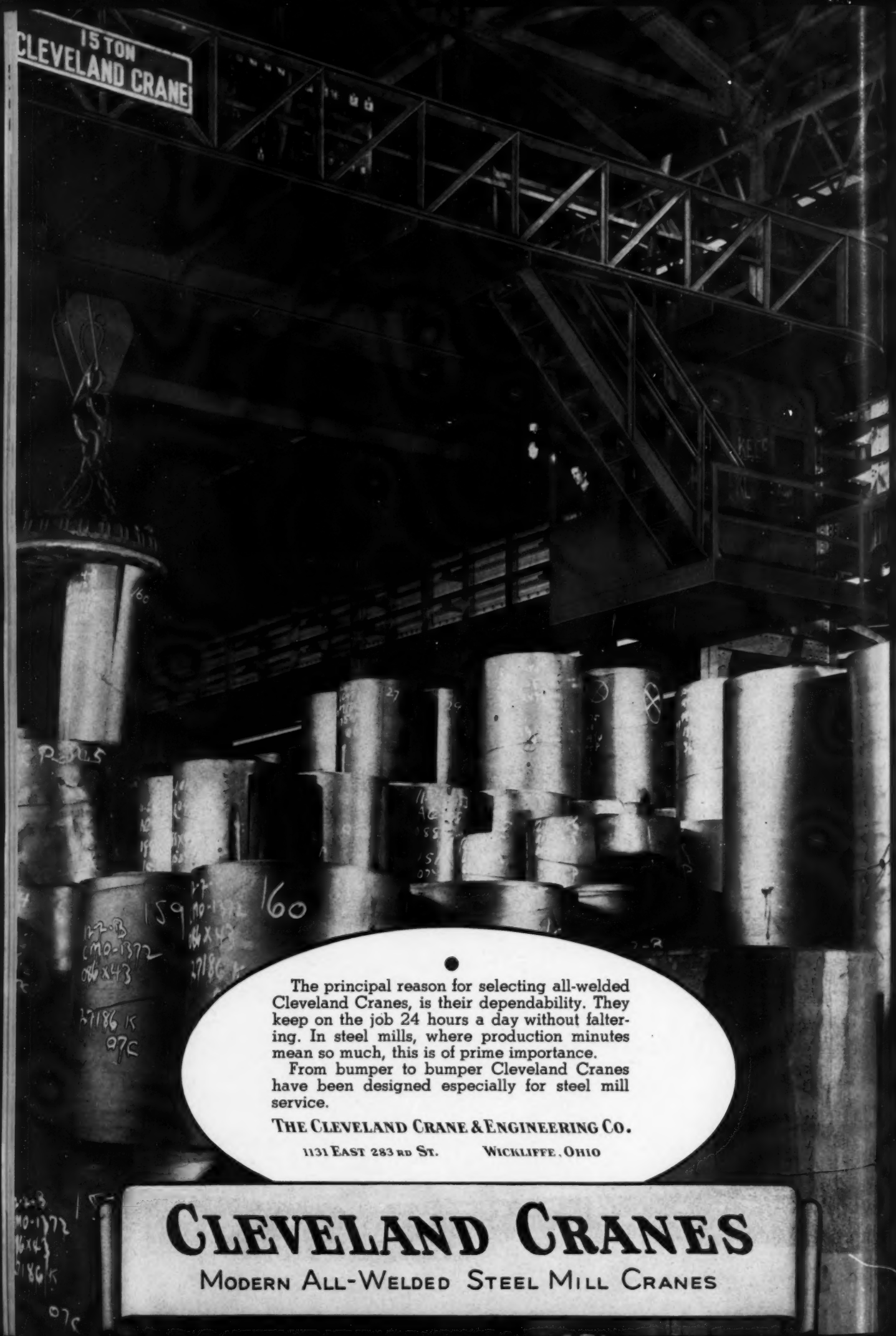


The principal reason for selecting all-welded Cleveland Cranes, is their dependability. They keep on the job 24 hours a day without faltering. In steel mills, where production minutes mean so much, this is of prime importance.

From bumper to bumper Cleveland Cranes have been designed especially for steel mill service.

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# CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

# Crops and Shorts

WALTER S. TOWER, president of the American Iron and Steel Institute, sees two classes of problems facing the steel industry in its reconversion. On one hand are internal problems, largely under the industry's own control and relatively easy to solve; on the other hand are numerous external problems, not within the industry's power to solve. In the first category are readjustment of facilities to normal operations, elimination of obsolete or uneconomic plants and equipment, disposition of government-financed facilities, return of veterans to appropriate places on payrolls, and readjustment of operations to normal working hours.

In the second category, and more difficult to solve, are prompt settlements under canceled war contracts, disposal of surplus resulting from such cancellations, removal of federal war agency controls, the revival of competitive markets in place of dictated markets, customers' problems of reconversion, the future of government owned plants, and the effects of trying to restore a war-torn world from a condition of near chaos.

▲

THEY say that only one year after Roentgen's discovery of the X-ray in 1895, a bibliography of scientific literature listed 400 titles on the new phenomenon. We'll bet that the atomic bomb and its ramifications beat that record.

▲

THE fact that the clothes you are wearing are charged doesn't necessarily mean that you have a magnetic personality.

▲

TESTS covering an extensive range of iron ores have shown that measurements of ore porosity afford a rapid method for comparing the reducibilities of the ores. Such measurements should prove useful in deciding the respective merits of different ore mixtures, as well as of individual ores and sinters. Apparatus for rapid determination of porosity of ores is described in the paper, "A Rapid Method of Ore Testing — The 'S.K.' Porosity Test," to be published in the Journal of the Iron and Steel Institute.

▲

TO the consternation of those involved, United States ideas of the postwar world are not being accepted by the world as eagerly as they had supposed. Perhaps those planning our domestic postwar life should pause and reflect.

▲

WARTIME accomplishments of some industries: The electric motor industry expanded from a prewar output of $17,000,000 per month to a peak of $82,000,000 per month.

The industrial power truck industry expanded from a prewar total of $7,000,000 to a peak of $13,000,000 per year.

The fan and blower industry increased its annual capacity from $50,000,000 to $110,000,000.

The annual capacity of the pump industry was raised from a prewar $100,000,000 to a maximum of $500,000,000.

Oxyacetylene welding and cutting equipment grew from $8,000,000 to $32,000,000 per year, arc welding machines from $10,000,000 to $41,000,000 per year, and resistance welding machines from $3,000,000 to $17,000,000.

The conveyor and mechanical power transmission industry boosted annual production from its prewar $150,000,000 to a peak of $411,000,000.

▲

AN interesting — and factual — story is that of the American manufacturer who recently lost a sizable order for equipment in Mexico to a British concern who could make better delivery — with lend-lease material.

▲

ACCORDING to the Houghton Line, a gold digger is only a woman after all.

▲

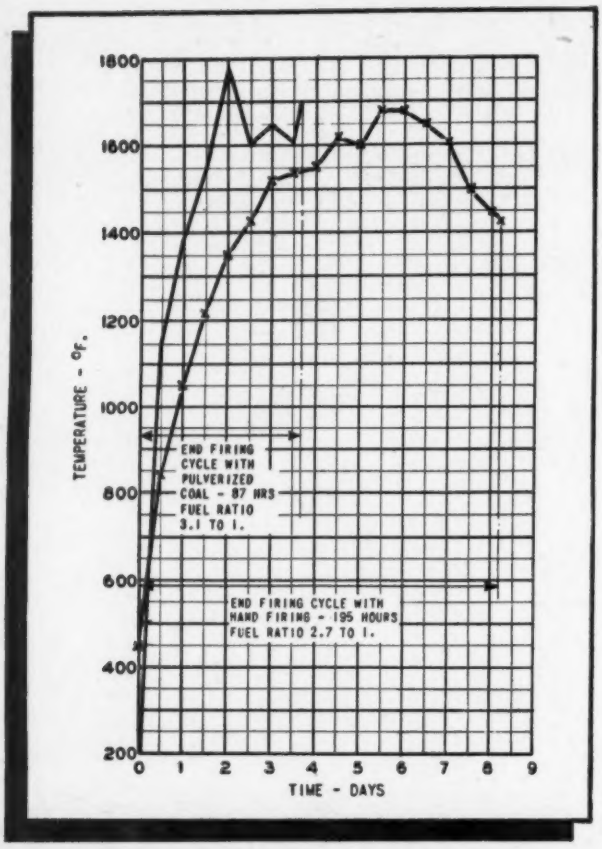
TIN undercoats on painted steel have been found to add materially to corrosion resistance. Investigations covered electro deposits of tin from both alkaline and acid tin baths, using thicknesses of .000008 and .00003 in. with both flash-melting and oxidizing chemical treatments, and employing various kinds of paints and lacquers. Results indicate that .00003 in. of electrodeposited tin from a sodium stannate bath, further protected by the Tin Research Institute anti-rusting oxide film, forms the best undercoat for subsequent painting.

▲

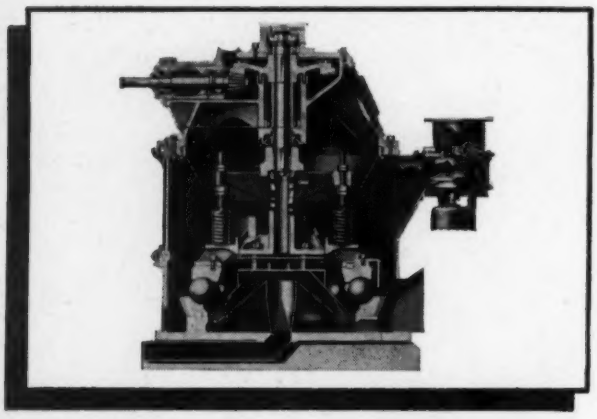
THE series of one-day regional meetings, which this year supplanted the A. I. S. E. national convention, is over. The trail, which started in Birmingham September 17, led on through Detroit (September 24), Pittsburgh (September 26), Chicago (October 1) and Cleveland (October 3), and ended in Philadelphia, October 6. Technical sessions in these cities presented, in the aggregate, the same schedule of papers that would have been used had a national meeting been held. Attendance at the six meetings totaled 1975.

Kelly awards for 1944, announced during the meetings, went to Ross E. Beynon, Carnegie-Illinois Steel Corporation, for his paper "The Rolling of Semi-finished Steel"; D. Bruce Johnston, Lukens Steel Company, for his paper "Ferrous Electric Welding — Fact and Fable"; and to Samuel Epstein and R. C. Hess for their paper "Bearing Metals in the Steel Industry."

# 56% Faster Annealing with Less Coal




Time-temperature curves showing time saving of pulverized-coal firing over hand-firing 30-ton malleable-iron annealing furnace.



B&W Type B Pulverizer as arranged for supplying coal to circulating systems for firing metallurgical furnaces.

By changing from hand-firing to direct pulverized-coal firing with the B&W Circulating System, firing time on five malleable iron annealing furnaces was reduced 56 per cent. Furnace output, in tons of castings annealed per ton of coal, jumped from 2.7 to 3.1.

ONE pulverizer serves all five furnaces through a single pulverized-coal circulating line that is looped overhead, out of the way. This simple arrangement of the B&W system eliminates multiple piping and coal-handling equipment necessary for direct firing individual furnaces, keeps floor space around the furnaces clear for product handling, and effects substantial economies in installation maintenance.

Flexibility in multi-furnace operation is obtained by providing as many take-offs to burners as required, and because burners may be turned on or off as desired. Furnace temperatures are controlled easily, by methods similar to those used with gas and oil firing.

Results from this installation have been so satisfactory, from both operating and economy standpoints, that a second B&W system of the same type has been planned to fire six other annealing furnaces in the same plant.

For detailed data on this simplified system of pulverized-coal firing for metallurgical furnaces, write for Bulletin 3-365.

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Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

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# Why "Regulex" is No. 1 Arc Furnace Control

## LOWER MELTING COSTS, REPORTED BY SCORES OF ELECTRIC FURNACE OPERATORS WHO USE RUGGED REGULEX ELECTRODE CONTROL, HELP EXPLAIN ITS RAPID RISE TO TOP POPULARITY

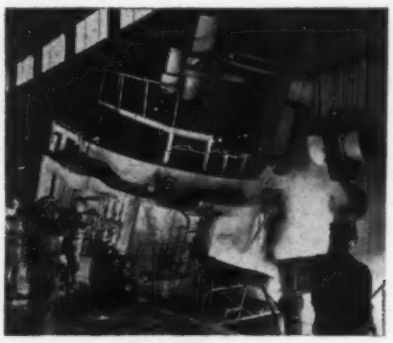
TODAY, Regulex control is acclaimed as *the most popular of any modern arc furnace control.* By its low maintenance and superior performance, it has outmoded conventional, slow-acting controls of the contactor type.

The Regulex control consists of a very simple, continuously-connected system of generators and motors.

Regulex generators, one for each electrode motor, are driven on a common shaft from a standard induction motor.

### Balanced Control Circuit

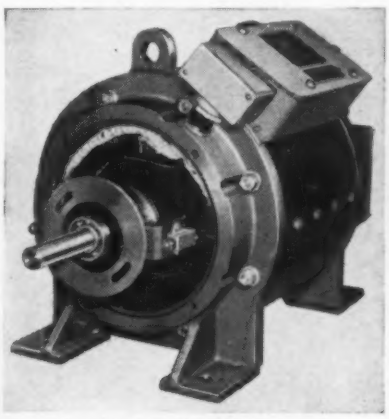
The Regulex system is able to adjust itself to any demand, no matter how small or how large — an important characteristic in an arc furnace control.



Furnace Using Regulex Control

When the balance of voltage and current in the furnace arcs is upset, the control fields of the Regulex generators become correspondingly unbalanced. Instantly, the control supplies an amplified voltage to the electrode motors, causing them to raise or lower the electrodes, correcting the power unbalance.

*Continuous, smooth, and stepless regulation results. No mechanical brakes are needed.*



Sturdy Regulex Generator

By accurately controlling electrode position during all the changing conditions of the furnace charge, Regulex control lowers kilowatthour cost per ton of steel, because wasteful current peaks are ironed out. Melt-down time is shortened . . . furnace production is boosted!

### Standard Machine

The Regulex generator is a sturdy, standard commutator machine, *which requires no tricky brush adjustments.*

Springs, levers, contactors, etc., are replaced in the control scheme by the Regulex generator, which has *only its armature* as a moving part. Maintenance is slashed!

### Unique Advantages

*As an exclusive feature, Regulex control can be equipped with flywheels, which automatically raise*

Regulex Control Flywheel Sets

*the electrodes when power fails. The auxiliary generator can make the entire control independent of a d-c shop source when desired.*

### Pays for Itself

Varied field experience has proved that in time and power savings, *not counting maintenance economy,* Regulex control often pays for itself within a few months. Kilowatthour consumption on furnaces equipped with Regulex control *may be cut as much as 10%,* in comparison with power costs on furnaces equipped with older-type controls.

### Ask Furnace Manufacturer

Your arc furnace manufacturer will be glad to tell you about Regulex control for new or existing furnaces. Or write directly to ALLIS-CHALMERS, MILWAUKEE 1, WIS.

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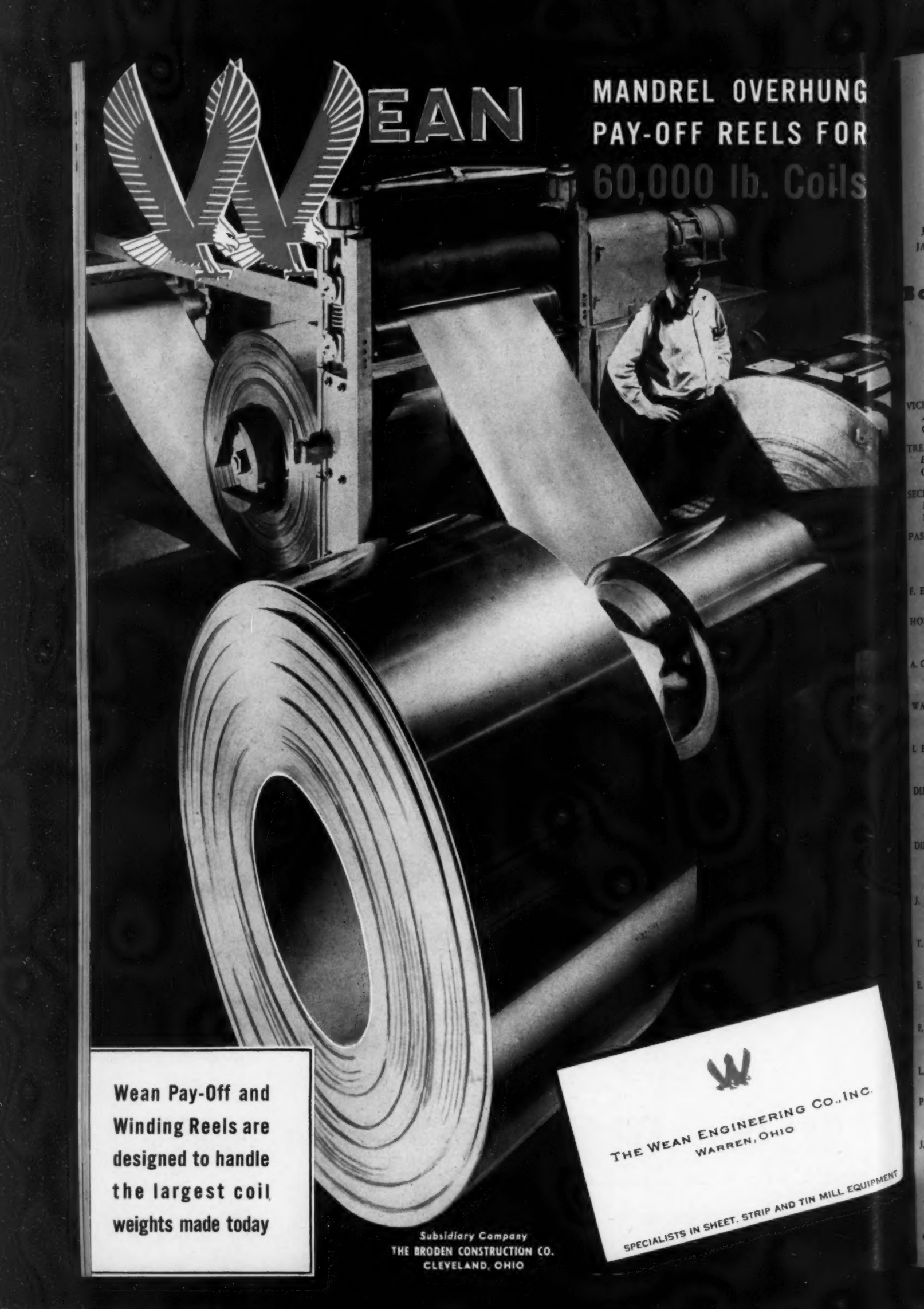
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# Iron AND Steel ENGINEER

OCTOBER, 1945 VOL. XXII NO. X

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# *Influence* OF THE CHARGE UPON *Open Hearth Furnaces*

*. . . . too little attention has been directed toward the character of the charge materials entering the furnace charge . . . . this article evaluates the effects of variations in the charge upon open hearth performance . . . .*

*by H. F. Lesso and R. W. McCann*

GREAT LAKES STEEL CORPORATION

DETROIT, MICHIGAN

▲THE economy of a steel plant depends upon the efficiency of its equipment. Although the efficiency of the individual unit has a definite maximum value, each unit experiences inconsistencies and fluctuations. Consider as an example, the open hearth furnace operation in a well integrated steel plant. The objective is not the normal production of the individual furnace, but rather the maximum production attainable with due consideration given to the quality of the steel to be produced and to the avoidance of economical inconsistencies such as may result in abnormal wear of furnace materials and a forced operation of the furnace. The productive capacity of a steel plant in general and the productive capacity of each individual open hearth furnace depend not only upon the size of the furnace but also upon the respective operating conditions resulting from abnormal irregularities in the character of the raw materials which the furnace receives.

The conflict just ended placed unprecedented emphasis upon the importance of sustained furnace operation to maximum productive capacity.

With future markets being highly competitive in steels of unusually close control in chemistry and quality, sustained production of large tonnages can be most successfully realized through supplying more consistent raw materials to the open hearth furnace. With the resultant melting and refining conditions being more favorable, the high quality standards of future steel products can be most economically maintained.

While the open hearth remains the large tonnage producer, with charge materials of extremely variable physical and chemical nature, foresight must be directed toward developing adequate methods which will provide for greater uniformity in the desired properties of charge materials, thereby aiding very substantially in furthering maximum production through extended individual furnace campaigns.

In view of the substantial difference experienced in the roof campaigns of a considerable number of furnaces, it appeared to be extremely advisable to review critically the character of the charge materials these furnaces had received and to present the findings on a comparative and representative basis, thereby providing some means for a relative evaluation. Recognizing the comprehensive nature of the raw materials problem in furnace operation, this study was not intended as providing a basis for exacting operational standards but rather to indicate trends in furnace production cycles when raw material abnormalities occurred. It is obvious to those skilled in metallurgical practices that seriously erroneous conclusions may be arrived at no matter how carefully the subject is studied if the data are not representative of the actual operating conditions. To be reasonably sure that the data would be of a representative nature, the charge materials of the individual heats of six complete campaigns were studied on the furnaces

Presented before A. I. S. E. Detroit District Section Meeting, March 13, 1945.

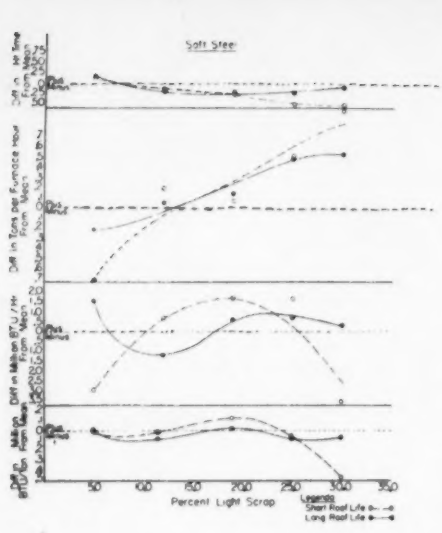



**Figure 1 — Effect of light scrap in the charge upon open hearth operation for soft steel.**

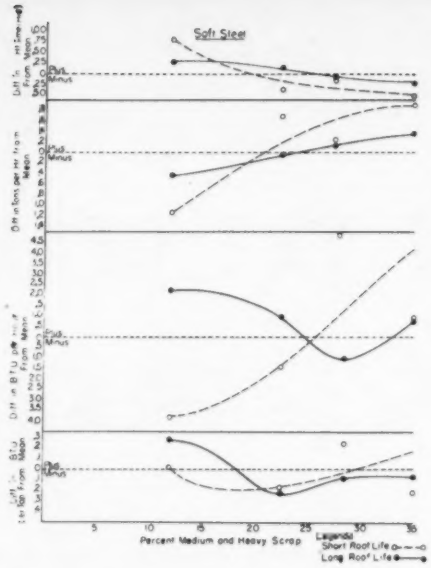



**Figure 2 — Effect of medium and heavy scrap in the charge upon open hearth operation for soft steel.**

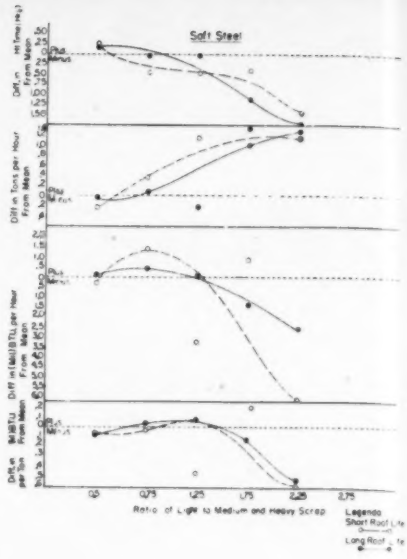



**Figure 3 — Furnace performance vs ratio of light to medium and heavy scrap (soft steel).**

with short roof life and the charge materials of the individual heats of four complete campaigns on furnaces with long roof life. The total number of heats statistically analyzed in the ten campaigns exceeded 1400.

Further, the furnaces selected were of sprung arch roof construction with silica brick of standard size; all furnaces were provided with the same type of fuel and with burners of like dimensions.

Recognizing the multiple reasons for roof failure, such as faulty initial construction, inferior refractories, improper charging technique with respect to positioning of scrap in the furnace, damage inflicted through mechanical charging, incorrect burner position relative to the roof knuckle, faulty flame character during melting and refining, air intake during charging, melting and refining, and type of steel made, there seemed to be relatively little remaining in the nature of responsibility which could be assigned to the furnace charge.

On principle, this conclusion is entirely erroneous, for a number of reasons, among which is the fact that the physical character of the charge materials influences very considerably the heat requirement in the melting period. As an example, small, thin, fine scrap, having a low heat conductivity due to the presence of a multitude of insulating air spaces which retard heat absorption by the scrap mass in the initial stages of melting, (which means not only a prolonged melting period, but also an abnormal degree of heat reflection to the roof) is very difficult to melt. Likewise, excessive amounts of large heavy sections of scrap are difficult to melt, due to their mass. Therefore excessive heat input is necessary through increased flame intensity. Also, the chemical

**Figure 4 — Furnace performance vs silicon content of scrap (soft steel).**

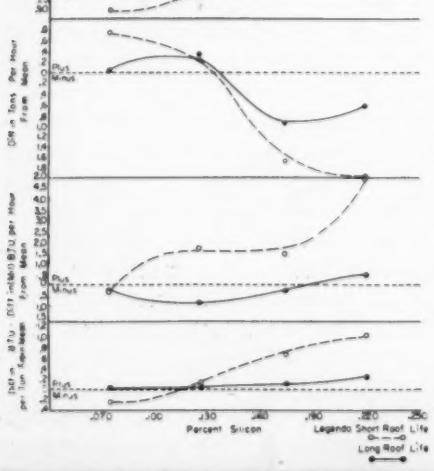



**Figure 5 — Furnace performance vs silicon content of total charge (soft steel).**

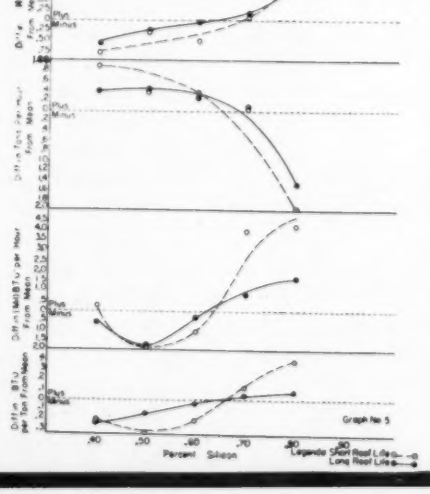
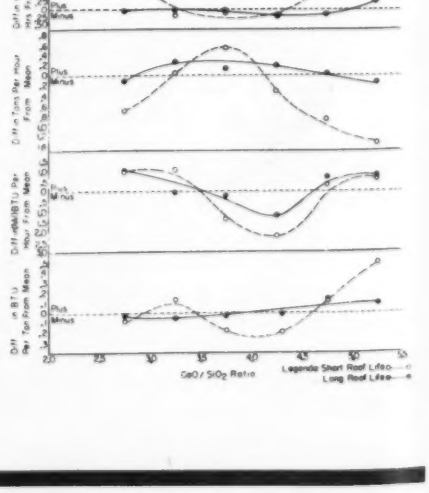



**Figure 6 — Furnace performance vs $CaO/SiO_2$ ratio (soft steel).**



personality of the charge materials exerts great influence upon thermal input, through the resulting conditions found in refining and finishing slags. As an example, the adverse effects of silicon and its oxidation product, silica, made evident by certain unfavorable physical characteristics in the refining and finishing slags, are so generally recognized that any scrap containing abnormal amounts of this acid element must be given special attention. Further, chromium-bearing scrap, which produces an oxidation product $Cr_2O_3$ (chromium oxide), forms additive compounds with iron which have a very high melting point. Besides detrimentally affecting the scrap-melting phase, it retards the refining period by rendering the slag viscous and inactive, particularly when the lime-silica ratio is on the low side.

Therefore, the responsibility of the charge materials relative to the roof campaign of the furnace assumes a role of definite importance.

The analysis of the solid materials phase of the campaigns was made with the view to determining the degree to which certain percentages and quantity relationships prevailed with respect to Btu input per hour and thermal requirement per ton of steel produced; also, how these findings were reflected in the production cycle of the furnace in heat time as well as the production rate in tons per hour.

In order that the quantitative influence of the individual materials could be appraised, the unit weight subdivisions (in per cent) covering the entire range of operations were made so that a considerable number of heats came within each group. Thus, by having a substantial number of heats in each group as representing the average unit influence of any one material, production variations resulting from certain operating variables would be cancelled out or substantially reduced.

The various types of scrap were divided into light, medium, heavy, and alloy classifications. Ratio values of light to medium and heavy scrap were considered individually. In appraising the chemical nature of the scrap, as well as the chemical nature of the total furnace charge, attention was focused upon the predominating acid element silicon. The oxidation product, silica, was dealt with on a ratio basis to the amount of lime that was required in refining operations, thereby considering slag volume. These phase subdivisions were employed in examining the thermal and production aspects on both soft and alloy steels produced in the furnace campaigns studied.

In considerng light scrap of such physical nature that it presents considerable surface per unit weight, more iron oxide will be produced per unit weight than in the case of heavier scraps. The amount of iron oxide produced will, however, be influenced greatly by the mode of charging. If light scrap should be placed in a furnace in such position as would be covered later with heavy scrap, less iron oxide would naturally be formed per unit weight. In general however, light scrap does exert a profound influence on the production rate of a furnace and heat input as can be readily observed from the data plotted in Figure 1. It will be noted in the Btu input per hour that considerable variation exists between the furnace campaigns, the short roof life furnaces having a substantially wider range of heat input per hour as compared to the long roof life furnaces. In Btu per ton, the trend in general is fairly parallel up to about 22.0 per cent light scrap, at which point the heat required per ton of steel produced becomes substantially less on the short roof life furnaces, whereas the Btu per ton on the long roof life furnaces varies consistently within relatively narrow limits. In tons per furnace hour it is quite apparent that the furnace charge must contain over 15.0 per cent light scrap if a favorable production rate is to be sustained.

With medium and heavy grades of scrap having a lower oxidation value in furnace charges, between 18.0 and 30.0 per cent was found to be consistent with economical production in Btu per ton. Again it will be noted that the Btu input per hour covers a wider range on the furnaces with short roof life than on the furnaces with long roof life.

**Figure 7 — Effect of light scrap in the charge upon open hearth operation for alloy steel.**

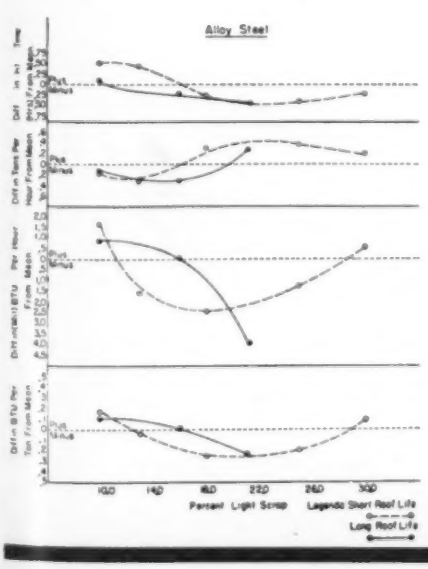



**Figure 8 — Effect of medium and heavy scrap in the charge upon open hearth operation for alloy steel.**

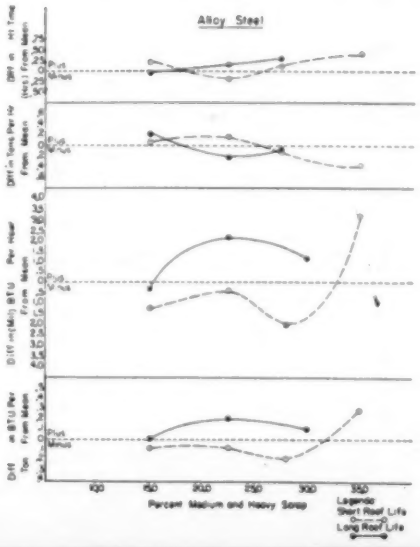
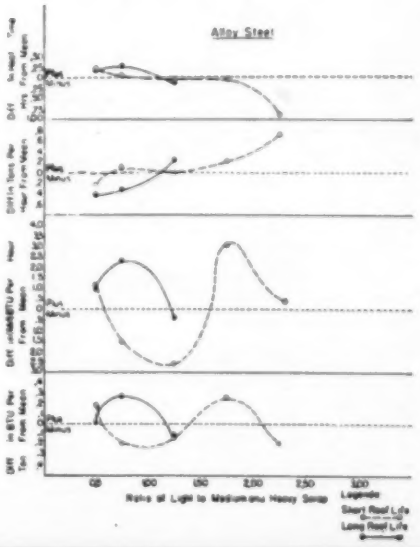



**Figure 9 — Furnace performance vs ratio of light to medium and heavy scrap (alloy steel).**



The production cycles of the furnaces were favorably influenced when the medium and heavy scrap represented at least 22.0 per cent of the furnace charge. These findings are given in Figure 2.

Unique quantity relationships between the above scrap materials were found to be relatively well established in both campaigns studied. When the ratio of light scrap to medium and heavy scrap reaches a value of around 1.25, the Btu per hour and per ton fall below the mean, with 2.25 being the relative proportions requiring minimum heat input. On the other hand, the production rates of the furnaces were favorably influenced when a ratio of 0.75 existed, reaching the most favorable production rate at a ratio between 1.75 and 2.25. These relative ratios are illustrated in Figure 3.

In Figure 4 the trends in furnace operations as influenced by silicon from the scrap are set forth. It is most obvious that a definite limit exists in the amount of silicon which can be contained in the scrap in furnace charge materials. At 0.13 per cent the production rate of the furnace and the production cycle of the furnace are both adversely affected, this limit being coincident on both short and long roof campaign furnaces. The Btu required per ton was not consistent with economical operations when the silicon from the scrap exceeded 0.115 per cent of the total charge. Figure 4 illustrates the adverse effect that silicon in the scrap has upon furnace operations. In Figure 5 the trends in heat requirements with the simultaneous decline in the production cycle of the furnaces resulting from increasing "charge silicon" are sharply defined. It is quite apparent that 0.50-0.55 per cent silicon contained in the furnace charge, with average operation, represents the optimum, with around 0.60 per cent silicon being the limit above which operational costs are affected. Previous studies made on "charge silicon" have not only confirmed the above findings but also revealed the silicon range for satisfactory operation to be influenced by the amount of light scrap in the furnace charge and quite naturally the per cent of limestone charged. As an example, it was found that with normal operations and 0.40 per cent charge silicon, the production cycle of the furnace was satisfactory with as little as 5.0 to 10.0 per cent light scrap; at 0.50 per cent silicon a minimum of 15.0 per cent light scrap was required for satisfactory furnace production, and when the charge contained 0.60 per cent silicon, over 20.0 per cent light scrap was necessary. At 0.70 per cent silicon in the furnace charge and with 20.0 per cent light scrap, the production of the furnace was adversely affected 3.5 per cent from the normal heat time. Therefore, in view of these findings it is manifestly necessary that, in any well integrated system for controlling furnace charges, silicon be given primary consideration.

At this point it might be expedient to enlarge upon the multiple influences that charge silicon has upon basic open hearth operations. Through a brief explanation, a more complete appreciation of the findings presented in the subsequent diagrams can be had.

Steel makers for many years have recognized the influence that silicon has in basic open hearth operations and are universally agreed that in scrap charge practice the principal prerequisite to successful and sustained operations is to avoid excessive amounts of silicon in the furnace charge.

It is an axiom that the tonnage an open hearth furnace produces and the yield realized from the ingot varies directly with the uniformity of the blast furnace operation and that, without exception, the open hearth plants sustaining maximum production were those receiving the most uniform iron. Quite naturally the pig iron (or hot metal) represents the major source of silicon in the furnace charge; therefore, abnormal variations in this element beyond the desirable limits, with simultaneous variations in the casting temperature (resulting in improper slag separation), are sharply reflected in open hearth production.

Considering the economic phase, the conversion cost put on the iron after leaving the blast furnace is of such magnitude that any abnormal condition which inter-

**Figure 10 — Furnace performance vs per cent of alloy scrap charge for alloy steel.**

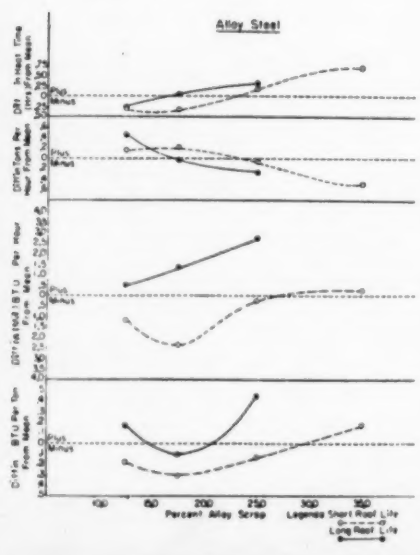



**Figure 11 — Furnace performance vs silicon content of scrap (alloy steel).**

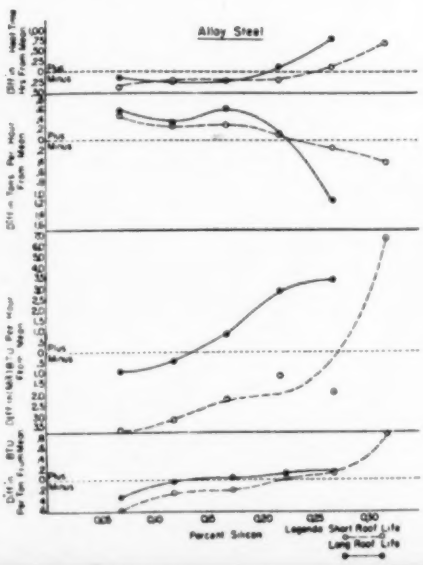
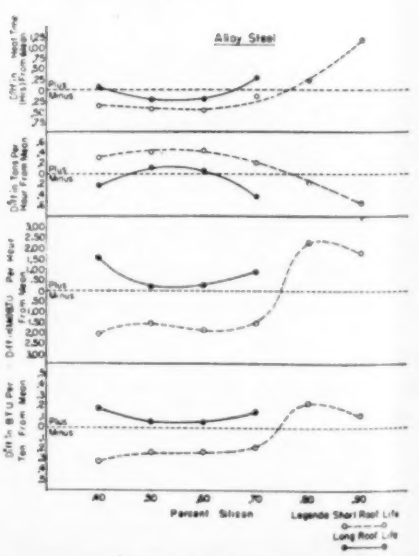



**Figure 12 — Furnace performance vs silicon content of total charge (alloy steel).**



feres with the quality of the iron so as to increase the subsequent conversion cost is adding materially to the total cost of the finished steel.

The problem of securing the proper quality of pig iron for use in the basic open hearth process is one of such vital importance that it is deserving of considerably greater attention than it has received in the past. It is too often assumed that the open hearth is able to accommodate itself to any grade of iron, but experience has demonstrated that the range is very limited. The uniformity of quality and silicon range of the blast furnace product takes on greater significance where the local production problems have to deal with a revert scrap containing substantial amounts of silicon.

All pit iron for the basic open hearth must contain some silicon, the reason being that other acid elements, phosphorous and sulphur, must, in the basic process, be eliminated in refining operations. These elements are eliminated from the steel and passed into the slag as calcium phosphate and calcium sulphide, and in order that these compounds of these acid elements may be held in the slag, it is necessary that an excess of lime be present. Should the pig iron contain no silicon it would be very difficult to form a fusible slag in which the constituents were calcium phosphate, calcium sulphide and the oxides of manganese and iron without going to very high temperatures or an excessive amount of iron and manganese oxides. Silica forms a fusible slag in the presence of the other compounds, thereby providing a medium which will retain the oxidized metalloids and nonmetallics. Therefore, silica may be considered a necessary evil. The latter statement must be interpreted correctly, for an excessive amount of silica in refining and finishing slags will result in slag conditions not only difficult to deal with but will also result in serious erosion of the furnace lining.

Silicon does, however, serve one very important function. Through its oxidation reaction with the iron oxide in the slag, it deoxidizes the slag so that carbon is not eliminated too rapidly. Its oxidation being exothermic, heat is generated, although the total heat thus generated represents but a very small proportion of the total heat requirement in furnace operation; nevertheless it does have that favorable property, particularly at the time when heat is most needed.

Pig iron of unduly low silicon content exerts an unfavorable influence on the progress of metallurgical reactions. With low silicon iron, the bath is cooled to such an extent that abnormal and often damaging heat input is necessary to prevent the bath from freezing. Excessively heavy slags which retard heat transfer and impede the progress of metalloid and nonmetallic elimination are most generally a result of low silicon iron. Low silicon metal is also frequently responsible in producing slags having a high surface tension which results in excessive foaminess. This condition is particularly hazardous, in that furnace roofs are very often cut severely in carrying on operations with foamy slags. It has been noted that foamy slags are associated with high ratios of lime to silica in the slag.

Iron of high silicon chemistry, through its oxidation, generates sufficient heat to fully compensate for the heat loss resulting from the carbon oxidation reaction. Further, deoxidation of the early slags is effected to such an extent with high silicon metal that the carbon range

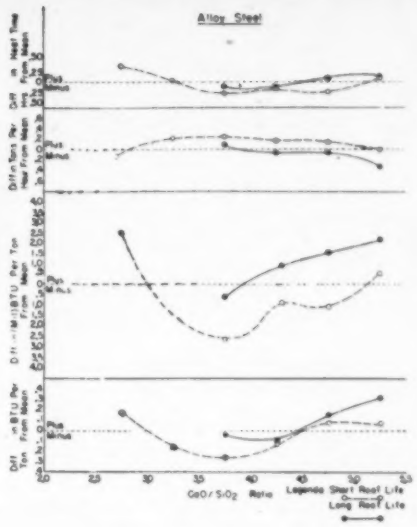



**Figure 13 — Furnace performance vs $CaO/SiO_2$ ratio (alloy steel).**

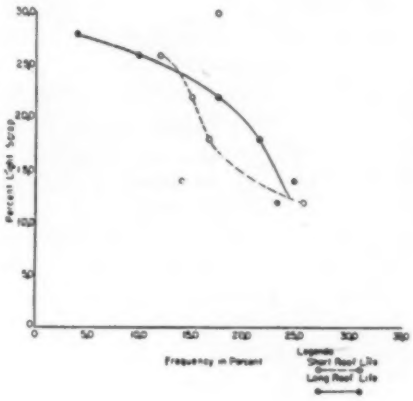



**Figure 14 — Frequency vs percent of light scrap in furnace charge.**

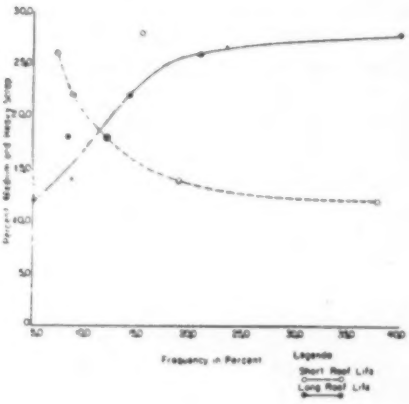



**Figure 15 — Frequency vs percent of medium and heavy scrap in furnace charge.**

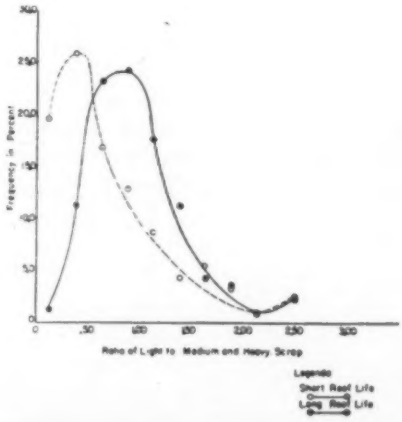



**Figure 16 — Frequency vs ratio of light to medium and heavy scrap in furnace charge.**

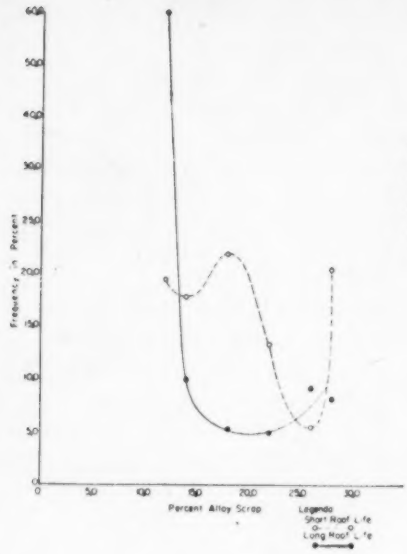



**Figure 17 — Frequency vs per cent of alloy scrap in furnace charge.**

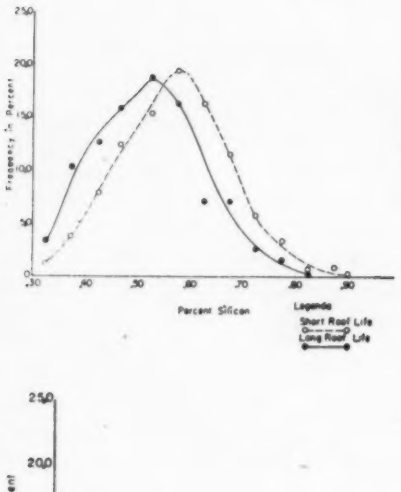



**Figure 18 — Frequency vs per cent of silicon in the furnace charge.**




**Figure 19 — Frequency vs per cent of feed ore.**

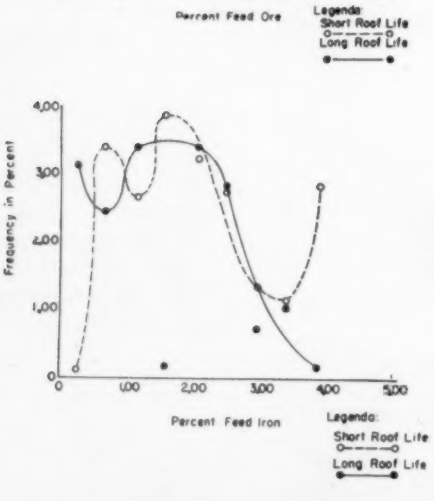



**Figure 20 — Frequency vs per cent of feed iron.**

at which the heat melts is most generally unduly high. The normal result of this condition is excessive feed ore additions. Heats receiving heavy ore feeding will also most generally develop a heavy foam, which is especially harmful to the roof of a furnace. In the case of high carbon heats, necessitating large fluorspar additions, this condition of slag foaminess is particularly harmful to the furnace roof. In addition, refining and finishing slags containing an abnormally high percentage of silica require additional lime to adjust the slag to the desired basicity. The resulting heavy slags disturb the normal production cycle of the furnace by retarding the rate of heat transfer.

The operational aspects of silica in refining and finishing slags are presented in Figure 6. It will be noted that consistently favorable furnace production was maintained on both furnaces with short roof life and furnaces with long roof life when the lime-silica ratio was around 3.75, with the required heat input being at a minimum with a ratio of 4.0 to 4.25.

The charge materials phase of the alloy steels produced on the individual campaigns also presents information of interest. It will be observed in Figure 7 that a minimum of around 15.0 per cent light scrap in the furnace charge is necessary to sustain furnace production above the mean, as was the case for soft steel. Minimum fuel requirement is found around 18.0 to 22.0 per cent light scrap.

In the production of alloy steels, furnace operations were not seriously disturbed with medium and heavy scrap in the furnace charge up to 28.0 per cent, but above 30.0 per cent all phases of furnace operations were adversely influenced (Figure 8). The ratio of light to medium and heavy scrap appears to be around 1.25 for minimum heat input, with furnace production being favorably affected at 1.50 (see Figure 9). Furthermore, precise weight limits of alloy scrap in the furnace charge were found to exist. In Figure 10 it can be seen that around 18.0 per cent permitted good production rate and minimum heat input.

Silicon limitations in the scrap when producing alloy steels still retains far reaching import. Figure 11 describes the quantity limits of this material. The findings on total "charge silicon" as previously dealt with in soft steel, on principle, also still hold for alloy steel production. Certain trend definitions do not necessarily parallel those found in Figure 5 for soft steel, but the limits in per cent are still clearly shown in Figure 12.

Furnace charges for alloy steels naturally contain a somewhat greater proportion of limestone; thus, as a result, the finishing slags more frequently carry a higher lime-silica ratio. Figure 13 defines ratios of 4.0 to 4.5 as being identified with satisfactory furnace operation in production of alloy steels in the basic open hearth.

In the curves presented up to this point, the one outstanding feature that has been clearly illustrated in the operations of the comparative campaigns has been the consistently greater range of variation in both the fuel and production phases on the short roof campaign furnaces than on the long roof campaign furnaces.

The scrap phase of the furnace charge has been dealt with quite extensively, revealing furnace operations as being sensitive to certain physical and chemical characteristics of the charge materials. However, a cross-section of the comparative campaigns studied with

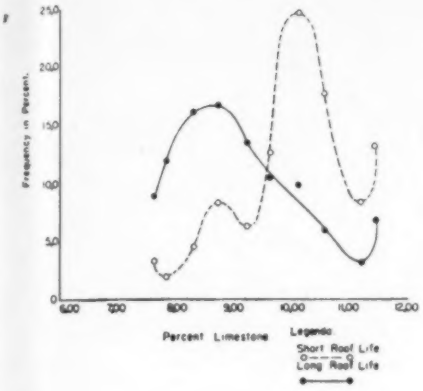



Figure 21 — Frequency vs per cent of limestone.

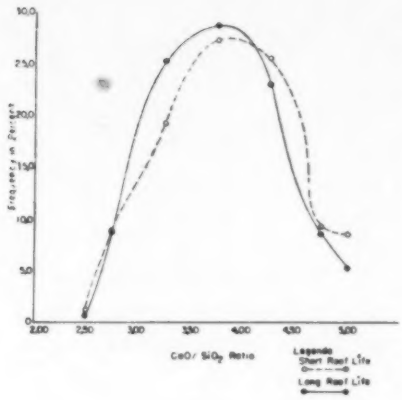



Figure 22 — Frequency vs computed $CaO/SiO_2$ ratio.

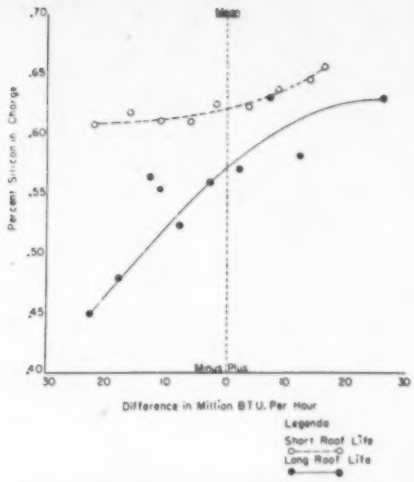



Figure 23 — Variation of fuel input with silicon content of charge.

respect to the solid materials phase could be more clearly presented with frequency diagrams.

Figures 14 and 15 reveal the range of variation in the per cent of light, and medium and heavy scrap contained in the furnace charges of the individual campaigns. Further, the charges on the furnaces with the short roof life were also more irregular in "weight" ratios than those of the long roof life furnaces as shown in Figure 16. This unfavorable trend in the proportioning and selection of scrap materials on the short roof life furnaces is further illustrated in Figure 17. In view of this substantial difference in the per cent of alloy scrap contained in the furnace charges, the more consistently favorable operation noted in the case of the long roof campaign furnaces can be readily appreciated.

The frequency curves in Figure 18 also reveal the range of charge silicon on the long roof campaign furnaces to be more in keeping with that found in satisfactory furnace operation.

Furnace production can be maintained at a relatively high level when the range of melt-down carbon requires a refining addition of iron ore equivalent to approximately 1.5 to 2.5 per cent of the total furnace charge. In Figure 19 the frequency with which the required feed ore additions were made resulted in a production advantage on the long roof campaign furnaces. Further, in Figure 20, dealing with the feed iron requirements on the heats of the two campaigns, we again find an operating characteristic recognized as being an advantage on the furnaces with long roof life.

In Figure 18, presenting the "charge silicon" phase of the two campaigns, it was revealed that the heats on the short roof life furnaces had received, on the average, a higher "charge silicon." Confirmation of this fact is found in Figure 21, in which is shown the considerably greater lime requirements in furnace operations on the short roof life furnaces. The final diagram of the frequency series, Figure 22, merely adds additional confirmation to the findings shown on the previous plate.

The fuel consumption on any one furnace in the normal production period is quite naturally dependent upon the judgment and skill of the furnace operator. When considering the multiple phases and influences of the furnace charge as covered up to this point, it becomes most obvious that, for sustained and economical furnace production, the furnace operator must possess a keen faculty for detailed observation. In bringing into focus the thermal aspect of furnace operations, the chemical phase of the furnace charge (the influence of which is sharply reflected in subsequent refining operations) was initially considered. In Figure 23 the trend in Btu input above and below the mean was set up as the abscissa with the per cent silicon in the furnace charge as the ordinate values. It can be readily seen that in both campaigns the inclined pattern of the curves indicates that the bath conditions developed with increasing "charge silicon" required an increase in thermal input.

In Figure 24, dealing with per cent feed ore versus the range of Btu per hour, relatively little can be concluded for the reason that differences in the oreing rate would influence the degree of heat input. It is shown, however, that the range of Btu input on the long roof campaign furnaces is somewhat greater than on the short roof campaign furnaces.

The heat requirement in the case of feed iron is of interest. In Figure 25 the maximum per cent of feed iron that can be used in refining operations as defined by the curves is 1.0 to 1.25 per cent, beyond which the Btu input increases.

The influence of limestone (as reflected in slag volume) upon Btu input per hour is shown in Figure 26. In the case of the long roof campaign furnaces, a progressive increase in the per cent of limestone used resulted in a steadily increasing heat requirement. On the short roof campaign furnaces the somewhat larger per cent of limestone required was promptly reflected in increased heat demand.

Figure 27 adequately expresses the meaning of favorable and unfavorable operating characteristics as related to furnace production and fuel demand. It will be observed in the upper half of the curve, designating a production rate above the mean, that the long roof campaign furnaces were operated within a narrower

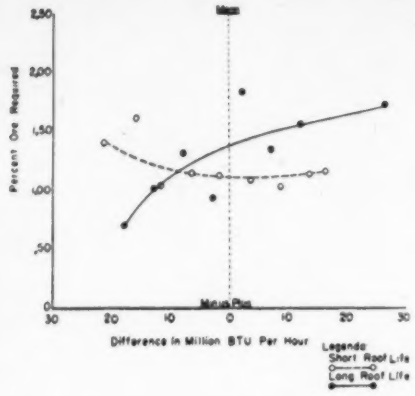



**Figure 24 — Variation of fuel input with feed ore requirements.**

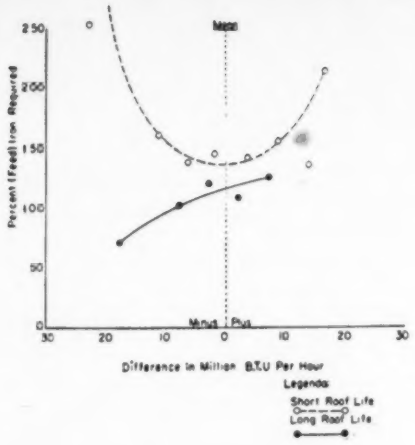



**Figure 25 — Variation of fuel input with feed iron requirements.**

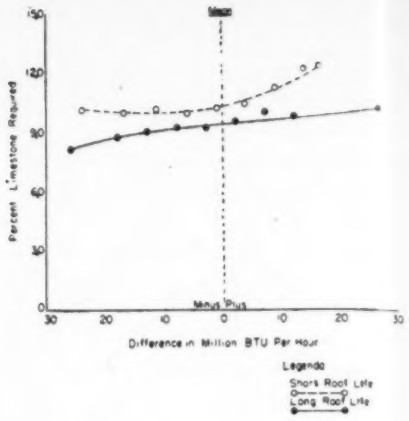



**Figure 26 — Variation of fuel input with limestone consumption.**

range of Btu per hour than the short roof campaign furnaces. In the lower half of the curve, representing the production rate below the mean, the long roof campaign furnaces were operated with a greater range of heat input per hour. This suggests the influence of efficient furnace operations, with the additional indication that, when refining conditions were inherently favorable, adjustments in fuel practice were made accordingly.

The fuel phase in steel production is most generally dealt with, however, on a Btu per ton basis. Therefore, presenting the trends in fuel consumption, using this basis of unit heat requirement in comparing the chemical nature of the furnace charge and the refining conditions experienced, should provide information of fundamental value. Figure 28 expresses the influence of "charge silicon" in its operating relationship to Btu per ton on both short and long roof campaign furnaces. Furnace operations on ore additions are shown somewhat more clearly on a Btu per ton basis than on the basis of fuel requirement per hour (Figure 29). Figure 30 directly describes the trend in fuel consumption where operating conditions are characterized by feed iron additions in refining. The inclined pattern of the curves in Figure 31, describing fuel consumption versus per cent limestone required, remains in parallel to those shown in Figure 26.

A preliminary summary of the respective campaigns, with the production phase and range of unit fuel requirement per ton as the focal point, can be found in Figure 32. Although the curves do not necessarily lend themselves to ready interpretation, there are several significant operating features contained in the diagram. In the long roof campaign furnaces, the results of the greater frequency with which a more appropriate selection of raw materials constituted the furnace charge are clearly shown in the upper left section of the diagram. When operating conditions were rendered difficult due to abnormal charge material conditions, the production rate of the long roof campaign furnaces fell below that of the short roof campaign furnaces, as shown in the lower right section of the diagram. The trend in operations as defined by the curve for the short roof campaign furnaces, although relatively similar in pattern to the companion curve, provides material evidence of the fact that, with the greater irregularity in furnace charge materials as found in this analysis, the result was promptly reflected in the production cycle and range of fuel consumption of the furnace.

In comparing the positions of the individual points on each curve, some support is given to the conclusions that the fuel demand per ton of steel produced was somewhat higher on the short roof campaign furnaces. From a cross-sectional inspection of the diagram, the general impression given would seem to suggest an advantage in production rate to be with the short roof campaign furnaces. This is actually not the case however, for an overall average of the production rate of the individual campaigns, revealed the reverse to be true to the extent of 0.4 per cent.

A final summary of this study, embracing the multiple phases considered, presented a somewhat difficult problem. Not only was it necessary to include the overall range of operations in heat input per hour and the production cycle of the furnaces, but also the average range of operations in plus and minus values from the mean, and having these operating data identified with the various material phases studied. After consideration, Figure 33 was selected as providing a representative expression of the comparative operations on the two types of furnace campaigns.

This graphic picture deals with the "influence of the charge materials on heat input per hour." The vast difference in the range of heat input per hour between the two types of campaigns is brought out by the length of the horizontal bars, with the individual material phases influencing the fuel consumption readily identified.

In like manner Figure 34 presents the average comparison in range of heat time between the respective campaigns, with the unit influence of the individual charge materials also being shown. Generous evidence is provided by the range of operations identified with silicon on the two bar diagrams that the function pertaining to silicon occupies such a pivotal position as to virtually constitute the very nucleus of successful and sustained furnace production.

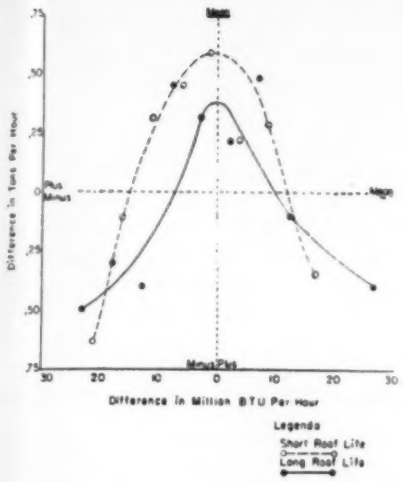



**Figure 27 — Variation of fuel input with production rate.**

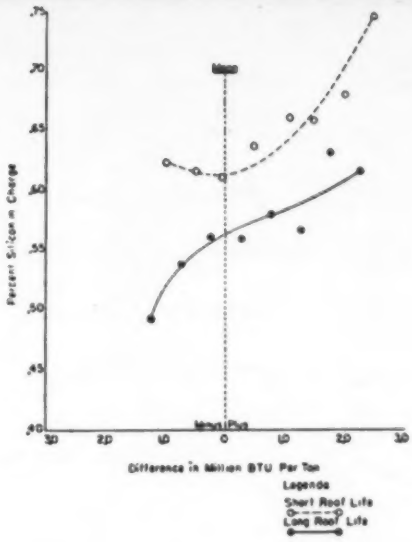



**Figure 28 — Variation in fuel consumption vs silicon content of charge.**

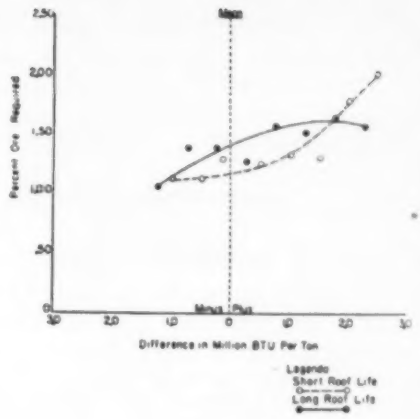



**Figure 29 — Variation in fuel consumption vs feed ore requirements.**

The efficiency of a steel producing unit and its position in the economic order of things is directly related to several factors. From a processing standpoint, consideration must be given the consistency of good melting carbon ranges. This phase of operations can be a reasonable measure of the production rate of the furnace. To illustrate the meaning of this statement Figure 35 was developed. That some degree of significance may be attached to the data shown in these curves, each point defining the trend in operations is an average value of 100 to 200 heats in the case of pig iron and a 50 heat average for each point on the iron ore line.

These curves are quite indicative of the extent to which refining additions in ore and feed iron can be made in normal processing for economical or uneconomical operation. With ore additions, the point of borderline practice is shown at around 2.5 per cent, whereas with cold pig iron additions the point of intersection representing a borderline production cycle is approximately 1.25 per cent. Therefore, the required refining additions become a prominent factor in furnace production capacity. An increase or decrease of 0.1 ton per hour in production rate alters the economic position of the furnace approximately 0.7 per cent of one per cent.

Quite generally speaking, with mixed scrap schedules, only a suitable mixture of the available types of scrap will insure good results, as has been adequately demonstrated. A preliminary condition for the possibility of mixing the various types of scrap is their separate and convenient storage and a well-balanced scrap supply. Abnormal deliveries of scrap can in no case be economically worked up, especially if storage facilities are limited or exhausted. Under such conditions, it is obvious that the various types of scrap specifically suited to certain grades of steel and certain furnaces cannot be

**Figure 30 — Variation in fuel consumption vs feed iron requirements.**

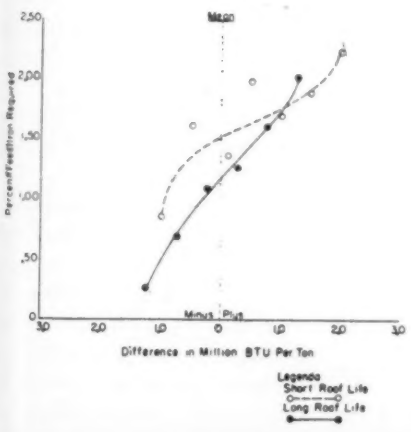



**Figure 31 — Variation in fuel consumption vs limestone required.**

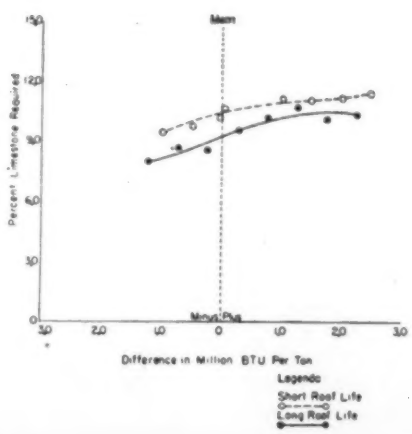
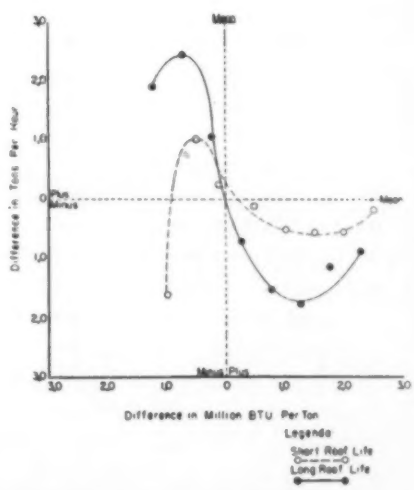



**Figure 32 — Variation in fuel consumption vs production rate.**



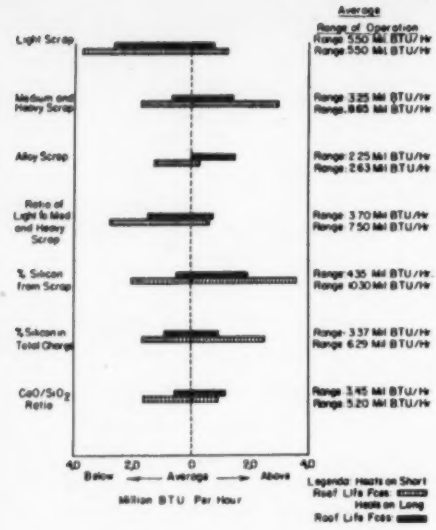



**Figure 33 — Influence of charge materials on fuel input.**

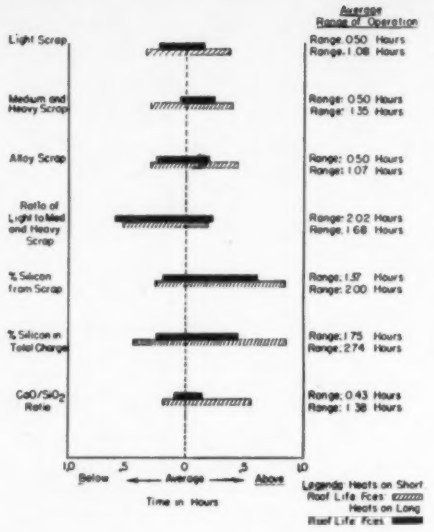



**Figure 34 — Influence of charge materials on heat time.**

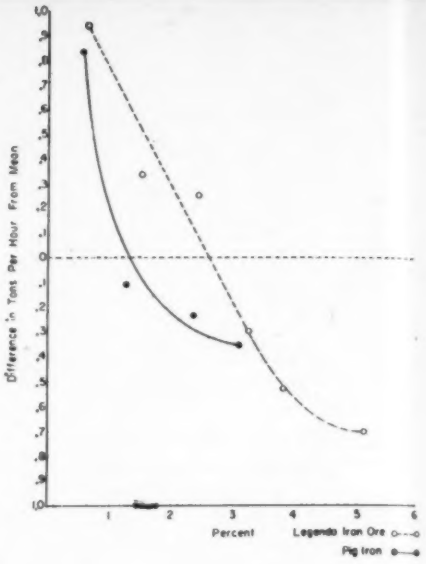



**Figure 35 — Melt-down requirement in per cent of ironore or pig iron vs production rate.**

utilized to the best advantage. Exceeding established equilibrium conditions entails disturbances in the favorable production cycle of the furnaces, thereby impairing the economic position of the unit.

There also exists a certain optimum pig iron for each open hearth plant, which meets the prevailing operating conditions in an especially favorable manner. Any deviations from this optimum composition will result in uneconomical operations, as made evident in an extension of the production time of the individual heats.

Despite the extreme variability of raw materials, the basic open hearth with its inherent thermal and metallurgical inefficiencies will undoubtedly continue to be the major source of steel ingot tonnage in the United States for many years to come. However, with steadily increasing metallurgical requirements, particularly in metallographic cleanliness and uniformity in physical and mechanical properties of the product, the importance of raw materials control takes on greater significance.

In view of that which has been presented the conclusions which may be reasonably drawn can be summed up briefly as being:

1. The physical and chemical characteristics of the raw materials charged into the basic open hearth furnace are in need of greater technical attention.
2. Through improved materials control practice, and the resultant more favorable operating conditions, it should be possible to carry somewhat higher refining temperatures (which is a prerequisite in producing metallurgically clean steel) and to achieve greater reproducibility in the quality of the finished product.
3. Substantial operating benefits in maintenance and material costs can be realized through suitably proportioned charge materials as based upon specific physical and chemical classification.
4. The economic position of the individual steel producing unit can be enhanced through extended furnace campaigns arising from greater attention to furnace charge materials.
5. Sustained furnace production at maximum capacity can be substantially realized through an efficiently developed charging technique.

Evidence of the fact that the findings in this study are in no way unique, individually nor collectively, can be found in a number of classical writings of 1908 by Carl Dickman and Ledebur. The former author in his book "The Basic Open Hearth Steel Process" recorded the following findings: "One per cent silica contained in the charge increases the heat demand 43 calories per kilogramme of steel. Likewise, there is effected by an impurity of one per cent silicon in the charge an increase in heat requirement of 15 calories per kilogramme of steel."

Ledebur, in his Eisenhuttenkunde of 1908 says: "With increasing amounts of the added ore, the difficulty increases of preserving a durable furnace lining. Only a part of the iron content is reduced from the ore in all processes for the production of soft steel from ores; the other part goes into the slag; finally also the productive capacity of the furnace diminishes whilst the fuel consumption and the wages increase." He goes on to say that when using iron ores it is of the greatest necessity to have them especially free of the impurity silica.

Since the time of the old iron masters notable progress has been made in the production methods of iron base products and alloys. However, the problems in future operations will require the greatest cooperation and collaboration between the empirical and technical minds. With these combined interests and efforts representing the modern force eminently needed in dealing realistically with certain economic conditions which constitute the very foundation of the open hearth process, the development of charging material standards embodying sound theoretical and operational principles can be carried to a greater degree of exactness. The potential development of a reliable and efficient charging practice will lend substance to the operational facts already presented. Operating benefits can be made available through controlled materials.

Although the analysis of the scrap phase as related to the production and fuel aspects on the furnace campaigns studied has constituted the bulk of this discussion, pointed emphasis has also been placed upon the fundamental uncompromising personality of silicon in order to indicate that this element in the charge material phase of basic furnace operations is in need of greater technological attention. Refinements to more exacting standards in the chemical identification, classification and physical preparation of scrap and other processing materials must also be an integral part of any system if the steel producing industries are to attain a position in precision standards comparable to that now enjoyed by other related metallurgical and chemical industries.

# DISCUSSION

PRESENTED BY


L. B. LINDEMUTH, Consultant, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

F. W. SUNDBLAD, Assistant Open Hearth Superintendent, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

H. F. LESSO, Process Control Metallurgist, Great Lakes Steel Corporation, Detroit, Michigan

P. E. HAGLUND, Melting Superintendent, Ford Motor Company, Dearborn, Michigan

H. E. PHELPS, Superintendent, Electric Furnace Department, Rotary Electric Steel Company, Detroit, Michigan

E. A. REINHARD, Superintendent of Production, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

G. A. FERRIS, Process Control Engineer, Ford Motor Company, Dearborn, Michigan

M. NEWSOME, Melter Foreman, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

A. NELSON, Melter Foreman, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

C. E. S. EDDIE, Assistant Superintendent, Power and Fuel, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

PAUL CARNAHAN, Superintendent, Steel Conditioning, Great Lakes Steel Corporation, Detroit, Michigan

A. F. DANZER, Superintendent, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan


**L. B. Lindemuth:** Mr. Lesso talked mostly of excessive amounts of various things. That is a comparative statement. If you go to Birmingham, Alabama, for example, you will find pig iron with 1.90 phosphorous. We get quite alarmed in the northern areas when the phosphorous climbs up to 1.40. Go to England and you find the normal phosphorous is 1.70; in Germany it is 2.25 to 2.50.

Those people get away with it. We would probably throw up our hands if we had to do the same thing. To them those figures are normal. If they were given our conditions, they would probably run into just as many adverse operating things as we would run into if we were given their conditions.

I am inclined to think that if these abnormalities were more normal to us, or if we adopt them as normal and expect them to be normal, we could do something about it. In other words, we could adapt our processes to take care of these things if we knew what they were and when they were, and so forth.

I think the particular value of Mr. Lesso's paper is to point out to us the things which are abnormal, and the effects thereof, and we should embrace those among the things we should hereafter consider normal.

**F. W. Sundblad:** Of particular interest are the conclusions arrived at regarding the effects of silicon upon roof life and tons per hour. On the basis of findings in this respect, what measures are recommended to counteract the negative effects of high silicon in the charge, especially in view of the fact that we shall probably have high silicon scrap after this war?

**H. F. Lesso:** Elemental silicon being the predominating acid element in the basic open hearth furnace charge, it quite naturally requires maximum attention. Providing sufficient flexibility in charging operations to compensate for abnormal variations of this element is not too difficult when a single source is to be dealt with; however, having a silicon problem in both hot metal and scrap does make operations somewhat involved. With a reasonably constant silicon value for scrap, desiliconizing hot metal if the silicon is unduly high or resiliconizing hot metal if abnormally low may have some value, but I doubt the practicability of such operations. However, with a fixed silicon value for scrap, variations in the amount of light scrap in the furnace charge would allow satisfactory operations over a considerable range of silicon in the hot metal, as was graphically illustrated. It was shown that with a total charge silicon of .40 per cent, as little as 5 to 10 per cent light scrap permitted satisfactory operations, but with a total charge silicon of .60 per cent, the light scrap required was about 20 per cent. Although the range of "charge silicon" was found to be quite substantial (.40-.70 per cent), confining operations to that approaching the optimum (.50-.55 per cent) can only be realized through compensating changes made by the responsible individuals dealing with the furnace charges. The magnitude of these charge modifications increases where a silicon-scrap problem exists, particularly in scrap charge practice; in high iron practice however, the problem of charge silicon does not require comparable attention.

Should postwar operations therefore require the consumption of considerable tonnages of silicon-bearing scrap, basic open hearth flush practice would appear to be the most likely method of operation in consuming heavy tonnage, with the acid open hearth and converter operations consuming the balance.

**P. E. Haglund:** I would like to ask Mr. Lesso how the melting rate is affected by alloy steel. How much longer does it require to melt alloy steel than carbon steel?

**H. F. Lesso:** That is a rather involved question. Initially, various alloy scraps contain elements which influence the amount of iron oxide formed per unit weight of material; this in turn would be influenced by the physical size of the scrap, exposure time in melt-

down, etc. Further, specific quality specifications and chemistry specifications are generally more exacting in alloy steel products than in straight carbon steel products. Therefore, it would be difficult to state with any degree of reliability any average time interval as representing the difference between the melting time of alloy steel and carbon steel.

**H. E. Phelps:** Don't you think it would be primarily a function of the chromium content of the scrap? For instance, you add chromium to steel to make it heat-resistant, which means less heat absorption.

**H. F. Lesso:** That is correct.

**E. A. Reinhard:** It has been mentioned that after the war we may be confronted with large tonnages of alloy scrap both from this country and from abroad. There is some doubt if there will be any large tonnage coming back from abroad.

In any event it is our opinion that alloy scrap that has been segregated will be charged in alloy heats and those scraps which are mixed will have to be charged in small amounts per heat and in time washed out.

**G. A. Ferris:** I would like to ask about the lime-silica ration. Why is it necessary to carry a higher lime-silica ratio with alloy steels?

**H. F. Lesso:** Present day alloy steels require as low a residual phosphorous as possible. Therefore, to be reasonably sure that phosphorous reversion will not occur when the alloy additions are made, a high lime-silica ratio is desired. Excess lime in finishing slags is definitely a prerequisite where major alloy additions are of pronounced acid character.

**M. Newsome:** Mr. Lesso's data should be of use to all of us, and I agree with him on the charge situation. To my way of looking at it, we must, if we expect to get high silicon scrap after the war, as Mr. Sundblad stated, compensate for it with a little less pig iron and more limestone.

**A. Nelson:** As Mr. Newsome said, we have an abnormal situation in the graph showing the silicon.

Let us take, as an example, a 500,000 lb charge, assuming that we will have a silicon situation to deal with. If you hold out 20 to 30 per cent of the required hot metal, the limestone charge based upon the final total charged weight approximates 7 to 8 per cent; with the reduced initial hot metal additions the limestone charge is automatically increased to approximately 10 to 11 per cent with this practice, the majority of the resulting melting conditions will require further hot-metal additions.

Should the melting conditions in turn require two or three additions of hot metal, the slag volume, although greater, will be in such physical condition as will result in a lower Btu input per hour. My experience with this practice has been very satisfactory on a three or four hundred ton furnace. We tried this at our plant on fifteen heats; they all worked very nicely. Occasionally we found it expedient to make a small iron ore addition prior to adding the remaining hot metal to complete the charge. This small ore addition generally improved the preliminary slag condition. Usually, however, the condition of the melt was such as to require but a small ore addition to complete the refining cycle after all the hot metal had been added.

**H. F. Lesso:** When you withhold a substantial portion of hot metal from the initial charge, you are simultaneously withholding a proportionate amount of elemental silicon from the initial charge. This permits the initial slags to carry a higher available base, and, as is generally known, basic slags build up in iron oxide more rapidly than acid slags; therefore, the heat would start with a slag more chemically favorable and less viscous.

**A. Nelson:** It will not necessarily be more viscous.

**H. F. Lesso:** No, it would not necessarily be more viscous, but should be of a favorable basic fluidity, as the initial slags would have sufficient excess lime to chemically neutralize the oxidized silicon; also, the lime-iron oxide binary system has eutectics of low melting point. It may, however, be necessary to make burnt lime additions after adding the remaining hot metal to maintain the desired slag body. Maintaining the preferred fluid state in refining slags not only permits good refining conditions but also low thermal requirement.

**A. Nelson:** We have never had to add burnt lime. We have always had a very good slag.

**H. F. Lesso:** How would you then compensate for the additional acid contained in the remaining hot metal additions?

**A. Nelson:** You would not have any more than you would in the first place. You started out with a 500,000 lb charge.

**H. F. Lesso:** I see your point, but what I was trying to show you was this. You had an acid-base relationship in the initial slag which permitted you to build up a favorable state of oxidation, and which generally is fluid. In other words, the initial slag composite is chemically more favorable in the practice you have described than in the initial slags where all of the hot metal is added at one time.

To recapitulate then, by holding out 100,000 lb of hot iron, you are keeping out a substantial amount of acid (silicon), thus leaving that much more base being available to develop the desired state of oxidation and starting the heat with a more favorable slag condition.

**C. E. S. Eddie:** In the first series of twelve graphs, how did you determine the mean abscissa? Was that mean based on a graphical representation or was it an algebraic function?

Another question, all through the discussion, there was mention of short and long campaigns. Just how many heats did that involve, and how many furnaces were considered over that period?

**H. F. Lesso:** The mean line values were arrived at in the following manner. After the heat input limits in Btu per hr and per ton were established for both the individual heats and the individual groups (i.e., the short and long roof campaign furnaces), the frequency data developed were in turn employed as the basis for computing the mean line values.

There was very nearly 100 per cent difference in the roof life of the campaigns studied. In the short roof life group, six individual furnace campaigns were studied; in the long roof life group, four individual furnace campaigns were studied, making a total of ten campaigns. All campaigns were selected at random. What was kept in mind however, was that each group was to include a comparable number of heats.

**Paul Carnahan:** I would like to ask what the relationship was between the number of alloy heats and of

common steel heats. I believe it was stated that the short roof life furnaces had a greater percentage of alloy. Was that variation comparable to the difference in roof life?

**H. F. Lesso:** In the case of the long roof life we had about 34 per cent production of alloy steel. In the case of the short roof life, we had 53 per cent alloy steel.

**H. E. Phelps:** In that connection, what type of scrap was the alloy scrap? Was it flashings or intermill scrap?

**H. F. Lesso:** Largely intermill scrap, primarily of silicon-bearing steel.

**G. A. Ferris:** In talking about the amount of alloy scrap conducive to maximum efficiency, you pointed out that 18 per cent of the total charge was about the best practice. What do you do in regard to government regulations that require 100 per cent of the scrap charge in alloy heats to be alloy scrap?

**H. F. Lesso:** We cannot use it, because our scrap situation is relatively unique. We have a basic process; thus we can only use a certain percentage.

**G. A. Ferris:** In other words, you cannot abide by that regulation. For instance, in making a chromium heat, you can charge 100 per cent chromium scrap — 100 per cent chromium back-scrap, we will say. You know you are not going to recover any great amount of chromium. You still can put the scrap in there and recover as much as possible.

**H. F. Lesso:** Have you operated that way?

**G. A. Ferris:** To a certain extent, yes. We agree that a high chromium oxide content in the slag is not conducive to good practice, but it is the law.

**H. F. Lesso:** You may also have in mind the production of special alloy steels, in which nickel and molybdenum are the elements to be recovered because of governmental control.

Our practice has been very successful in recovering nickel and molybdenum, because in the steels of that type that we have made, the silicon content was low, from .20 to .30 per cent; but when you have .60, .70, or .80 per cent silicon content in intermill scrap, your problem becomes rather awkward.

If we had to charge a furnace with 100 per cent alloy scrap of such silicon chemistry, we just could not operate with any degree of success.

I would also like to comment at this point about slag control. Slag control does occupy a very definite position in steel processing operations. The primary aims of slag control are to regulate the rate of reactions and thereby regulate to a degree the rate of oxidation of the steel bath. The chemical reactions which take place in the furnace operate under definite laws of physics and chemistry. These laws cannot be changed by any variety of manipulation, and any slag control which attempts to oppose these laws is bound to be unsuccessful. The initial basis upon which slag control is practiced on any heat of steel depends largely upon the prevailing conditions at the time; these conditions largely develop from the raw materials and therefore the real foundation of slag control is in the charge.

**A. F. Danzer:** You set a maximum of .60 per cent silicon in the total charge as being the maximum. Is that regardless of the use of slag control? Could you not increase your calcium and take care of a greater amount of silicon?

**H. F. Lesso:** You could, but you would increase the slag volume. As was graphically illustrated from actual operating data, increasing the charge silicon, with a simultaneous increase in slag volume resulting from the additional lime required, increases heat requirements and time of heat.

**A. F. Danzer:** It seems that whatever subject we start out on, we eventually wind up on the subject of scrap.

**H. F. Lesso:** Inasmuch as you are in an excellent position to evaluate the scrap situation, do you not think the present standards of scrap classification can be improved, so that we will really know what we are getting?

**A. F. Danzer:** Of course, there is always room for improvement. Identification of scrap, because of its nature, is difficult, but a continued demand from the consumer for better identification should eventually improve the grading.

**H. F. Lesso:** As a concluding comment, I should like to return for a moment to pig iron quality and open hearth furnace production. In a recent translation of a German publication, an interesting aspect of pig iron quality was discussed. It was found that iron of a certain chemical composition and physical condition was found to exert a very definite influence upon the course of open hearth heats.

These investigators developed an immersion test which proved to be a reasonable measure of the attacking power of the iron on the scrap in the furnace charge. The rod used for the immersion test was of the following dimensions and composition: 1½ in. diameter x 15.5 in. long; C 0.05; Mn .28; P .026; S 0.04; Si 0.010.

In evaluating their findings it was concluded that the viscosity of the iron could be recognized as a measure of the quality of the iron. The viscosity of the iron, quite generally speaking, being a function of the temperature, at higher temperatures the fluidity of the iron is greater.

Upon further investigation however, they also found that this fluidity and scrap-attacking power differed with certain chemistry ranges of the metal. From their experimental work they were able to determine the particular composition possessing the desirable properties and reported that the iron of 4.2 per cent C, 1.00 per cent Si, and 3.00 per cent manganese gave the best results.

In summarizing their results they listed the following conclusions:

1. The viscosity of iron is a function of temperature.
2. Regarding the carbon content, the ratio of combined carbon to graphitic carbon plays a determining role.
3. Combined carbon increases the fluidity of iron, while graphitic carbon lowers it.
4. This ratio is known to depend markedly upon the silicon and manganese content of the pig iron, with silicon favoring the graphite separation and manganese impeding it (or favoring the absorption of carbon).
5. Silicon renders the iron more viscous while manganese and phosphorous render it more fluid.

This is indeed of interest, for it indicates that the blast furnace product, when possessing the desired properties in chemistry and physical condition, can be of immeasurable aid in furthering open hearth production.

# MODERN *Electric Weld* TUBE MILLS

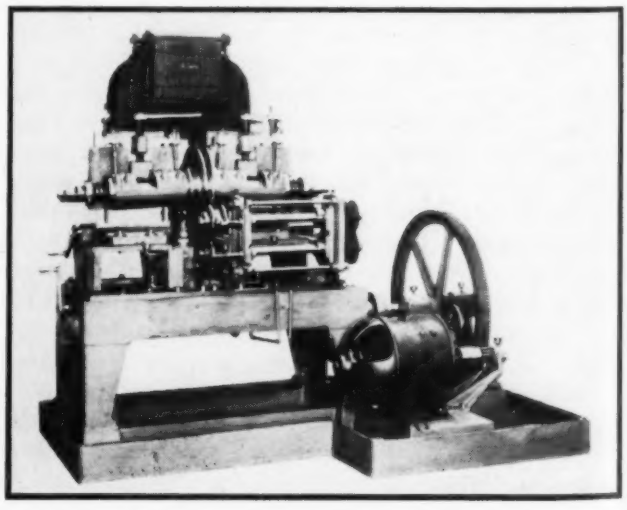
***. . . . electric welding has been increasingly applied to the production of tubing and pipe as these electrically welded products have received broader application . . . .***

*by John Lucas,* PRESIDENT
THE YODER COMPANY
CLEVELAND, OHIO

▲ THE process of making electrically welded pipe requires five or more units working together. We must first have a means of handling the coils or sheets of steel. Second, we must have efficient means of forming the strip or sheet into tubing. Third, we must weld it properly and cool it carefully. Fourth, we must size and round the welded tube; and fifth, we must cut it off on the fly. All of these operations must synchronize exactly. Many other operations such as edge conditioning, slitting, leveling and sand blasting are frequently done at the same time so that the operation can become quite complex.

The process of welding by heat, developed by resistance to the passage of a low voltage current through the high resistance gap of the seam, is not new. It has been done for many years. Equipment for forming tubing from strip and welding a tube continuously was developed commercially probably twenty-five years ago. A number of lines were built using alternating current and good tubing was produced. We have, in our files, complete designs of welders built about this time. Figure 1 shows a welder used at this early date. Shortly thereafter, G. B. Johnson applied for and obtained patents covering the welding of tubing by means of alternating current. These patents were assigned to Steel & Tubes, Inc., which became a division of Republic Steel Corporation. The manufacturers of that day looked at these patents and immediately questioned their validity, because there were a number of tube welding plants in operation before the patents were issued. The patents had been written, however, by a good patent attorney, and after being carried through many courts, were sustained and everybody was forced

**Figure 1 — Electric welding unit of early design for the manufacture of tubing.**



Presented before A. I. S. E. Philadelphia District Section Meeting, March 3, 1945.

to discontinue the making of tubing by the alternating current process unless under license to Republic Steel Corporation.

No one had so far paid much attention to direct current as a means of welding tubing, due to the difficulty of getting sufficient high amperage, low voltage current. Clayton Mark, of Chicago, Illinois, worked out a method of building a generator which would produce the proper current, and obtained a patent on this process twelve or fifteen years ago. This process is used by others, including Youngstown Sheet & Tube Company, by special arrangement.

In 1939 the Johnson patents expired and the general public was free to use alternating current as a welding means. We had been preparing for this event and immediately placed a complete line of equipment on the market, as did another company.

During the early days of welding tubing by alternating current, the greatest problem was getting the current to the tube at the welding point. It is difficult to transfer a large volume of current at voltages varying from 2 to 5 from the welding transformer to the revolving electrode. Many methods were tried. The most common employed massive laminated copper brushes, such as shown in Figure 2. Another method was to use hundreds of carbon brushes such as are shown in Figure 3. The efficiency of these methods was quite low, in most cases around 45 to 50 per cent. Quite a few welders are running today which are made this way. In fact, we built some ourselves which are still running. Still another method was to have a part of the revolving electrode dip into a pool of mercury which was directly connected to the transformer. Theoretically, this was a good idea. The bad feature was that the electrodes and their mountings had to be put in such a position that eddy currents were set up and objectionable local heating took place.

The electrodes themselves presented a considerable problem. You will find welders with electrodes mounted vertically, horizontally and at all points in between these extremes. Figure 4 shows one method of angular mounting. Most welders are built today with the electrodes mounted vertically. The results are good and it is easier to construct and maintain the machine. Various materials have been used for electrodes. The electrode gets severe service and should be as resistant to wear as possible. Unfortunately, the best wearing materials are not the best conductors of low voltage currents. A compromise has been arrived at and several companies are making good electrode material. With good electrode material and good welding practice, electrodes should not have to be dressed oftener than once each eight-hour turn. A dressing device may be built on the welder so that this is an easy job. This device is shown in Figure 5 at the upper right of the electrode.

The greatest forward step in tube welding was made when it was discovered that the transformer could be revolved with the electrodes. This permitted bringing the primary current into the transformer at line voltage through small brushes. The efficiency jumped to 85-90 per cent, and maintenance was greatly reduced. Several methods are used to do this. A number of makers use a special transformer built around a shaft. This makes a compact job but presents certain difficulties in maintenance and cooling. We feel that a standard transformer,

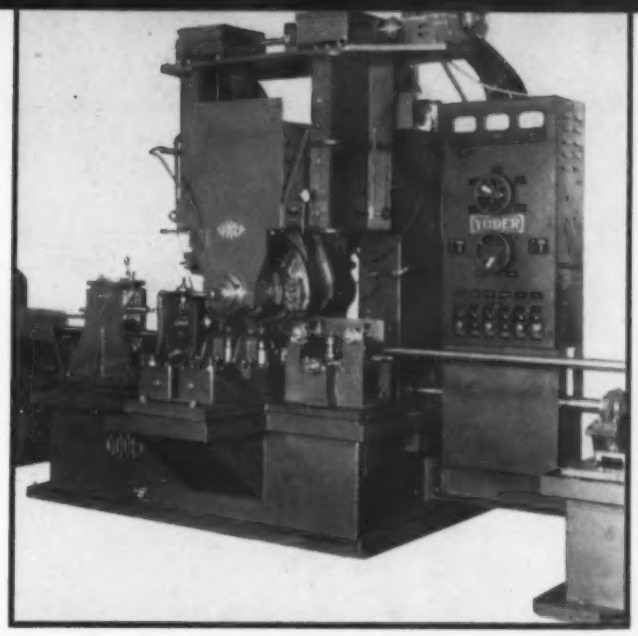
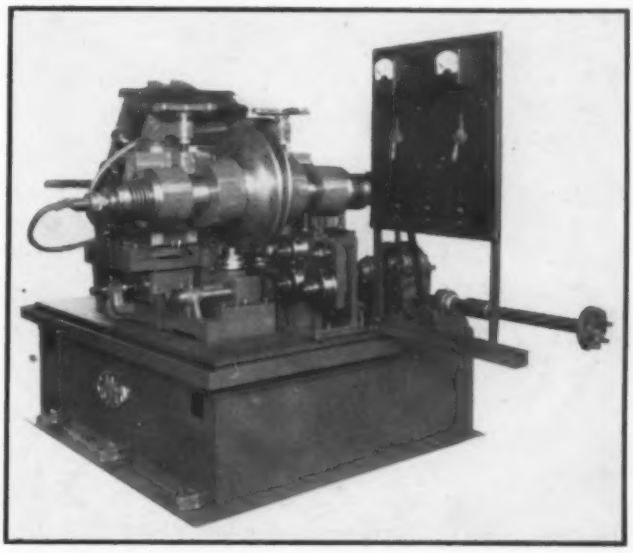


**Figure 2 — Welding unit in which low voltage welding current is introduced into the revolving electrode through heavy laminated copper brushes.**

**Figure 3 — A great number of carbon brushes was also used as a means of carrying current into the revolving electrode.**

▲

**Figure 4 — View of welding unit showing one method of mounting electrodes.**



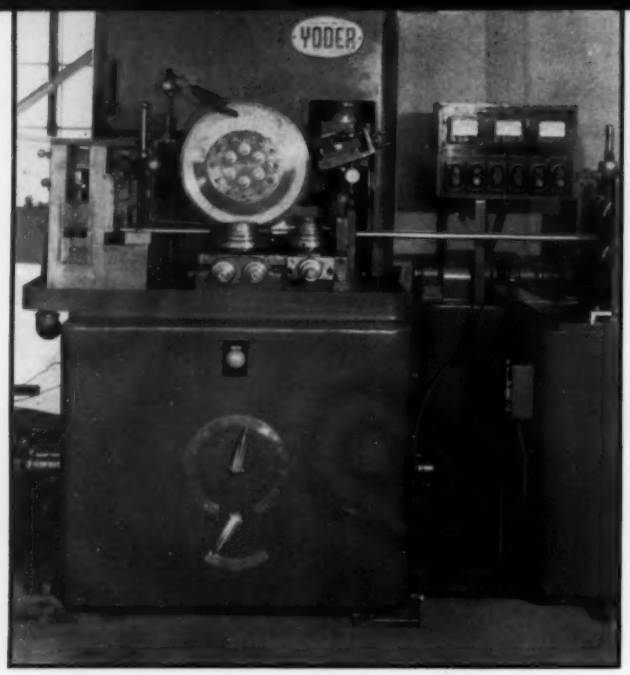



**Figure 5 — A device for dressing electrodes may be mounted on the welder, as shown at upper right of electrode.**

mounted in a revolving spider, gives us best results. Figure 6 shows this construction. Such a transformer can be built or repaired by any competent electrical company. It is also easily accessible and presents no cooling difficulties. A further advantage is that a transformer of larger capacity can be installed where extra power is required. Both the transformer and electrodes must be cooled by an ample supply of cool water. This may come from city mains or a cooling tower.

Many refinements have been added in recent years to increase the efficiency of mills and to reduce the labor required. Among the most important have been control methods. A very complete system of interlocking controls has been worked out for the larger mills where d-c motors can be used. Figure 7 shows a medium size welder with control panel. A complete pulpit-type control board gives the operator control over all units in the line, including starting, stopping, speeds and heats. The smaller mills are usually equipped with a-c motors, and speed is controlled through a variable speed device. All of the controls on the smaller mills are grouped for easy operation as shown in Figure 5.

One of the things requiring careful control is the current to the welding electrodes. The usual method has been to use an auto-transformer as a control means, using a multiple tap switch to get various amounts of heat. Such control works satisfactorily where the variable speed device for the mill can be infinitely adjusted. If tap No. 1 is not quite hot enough for a welding speed of 60 fpm, tap No. 2 may be too hot. The operator then presses the speed button until the increased speed shows just the right heat. This may be at 67 fpm. A combination of speed control with the auto-transformer taps gives excellent control. Today, however, we want what we want when we want it. For this reason, we have developed a new type of heat control, using electronic tubes. This method gives us infinite control without changing the speed of the mill, and is particularly advantageous when other operations are synchronized with the mill speed. The cost of such a control is slightly more than the one previously described but is not prohibitive.

Thus far we have not touched on welding speeds. Several years ago we installed an experimental mill in our plant to be used as a guinea pig. Previous to that time it was generally admitted that speeds above 70 or 80 fpm were not practical, as the welds would not be good. Our contention was that higher speeds were possible. The limiting factor was the frequency of the alternating current. Every cycle caused a so-called stitch which at high speeds would cause a weak weld or a leaker. Experiments were then made on current of higher frequency so that the stitches would be closer

**Figure 6 — In this unit the welding transformer revolves with the electrodes, so that only primary current must be carried into revolving parts.**

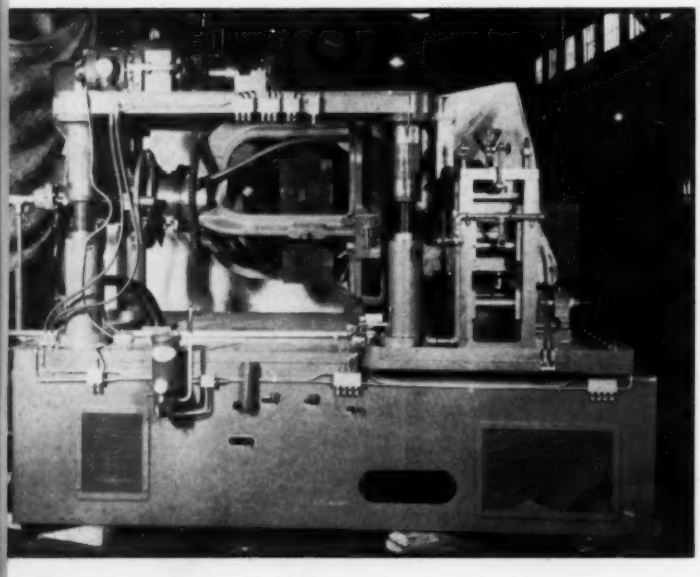
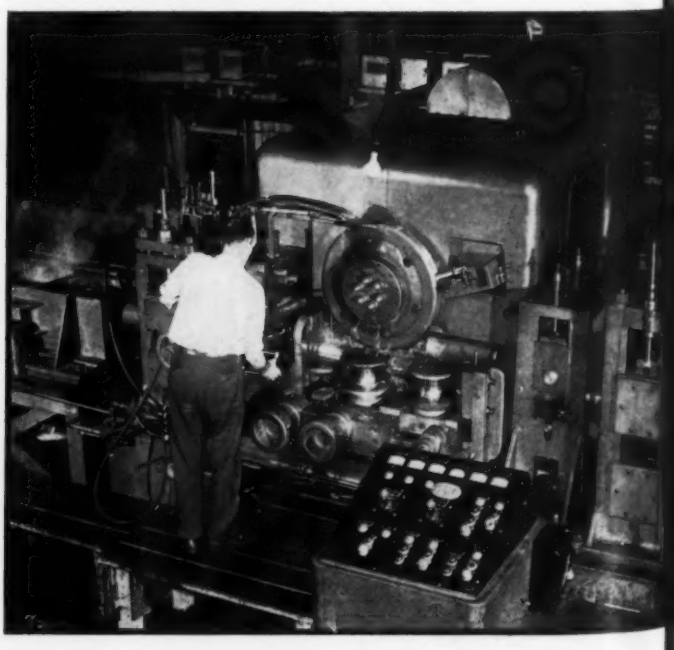


**Figure 7 — Medium size welder in operation. Control panel is shown in foreground.**



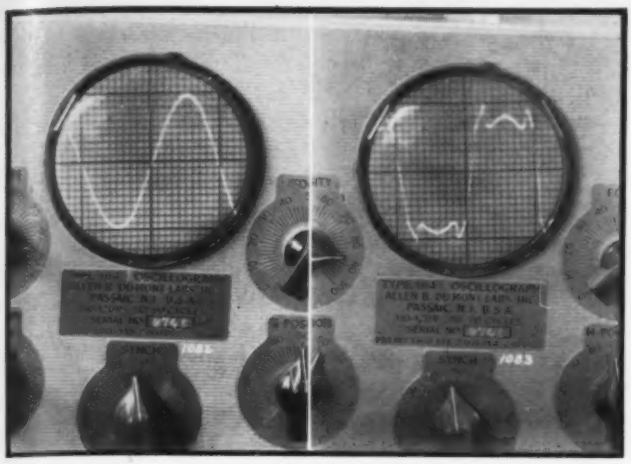


**Figure 8— Oscillograph indication of current from specially built generator at left, and of regular 60 cycle current at right.**

together. A frequency of 180 cycles showed a definite improvement; 360 cycle results were not much better than 180 cycles, but were harder to control. Experiments up to 1000 cycles are to be made shortly. The results, however, may not be known for some time. The use of the higher cycle current has enabled mills to run at continuous speeds of from 120 to 130 fpm, producing high grade boiler tubing. After studying higher frequencies, we thought that it might be possible to improve the results obtained from 60 cycle current, and a series of experiments gave reason to believe we were right. By proper heat control and control of steel analysis, we have produced tubing at 200 fpm, using 60 cycle current, which stood all of the tests tubing produced at 60 fpm would stand. We did find, however, that in most commercial installations, such speeds were too critical and required too careful attention to be practical.

One of our experiments has produced a substitute for higher frequency currents. We have developed a new type of current from a specially built generator. It will be noted on the oscillograph picture (Figure 8-A) that the wave of this current has a very peculiar shape. As compared to the regular 60 cycle wave (Figure 8-B), it breaks sharply but fades in the middle. By using the generator current with the 60 cycle line current, we get a wave which breaks sharply and gives us a much more constant heat than the well known 60 cycle, the theory being that the stitches are much less pronounced than with 60 cycle. In actual practice, this proves to be the case. This new process is still under development and may be offered in the near future.

D-c mills have one big advantage. There are no stitches to worry about, but the question of current, however, is important. D-c mills require large generators or other current producing devices which are quite costly. We have built d-c welders experimentally, and obtained speeds up to 400 fpm while making perfect tube. Figure 9 shows a d-c type of mill. Our experience indicates that the problem of efficiently getting the low voltage current from the generators or other current producing means to the electrodes is a difficult one. With a-c you can revolve the transformer and only transmit primary current at line voltage, but with d-c you must transmit

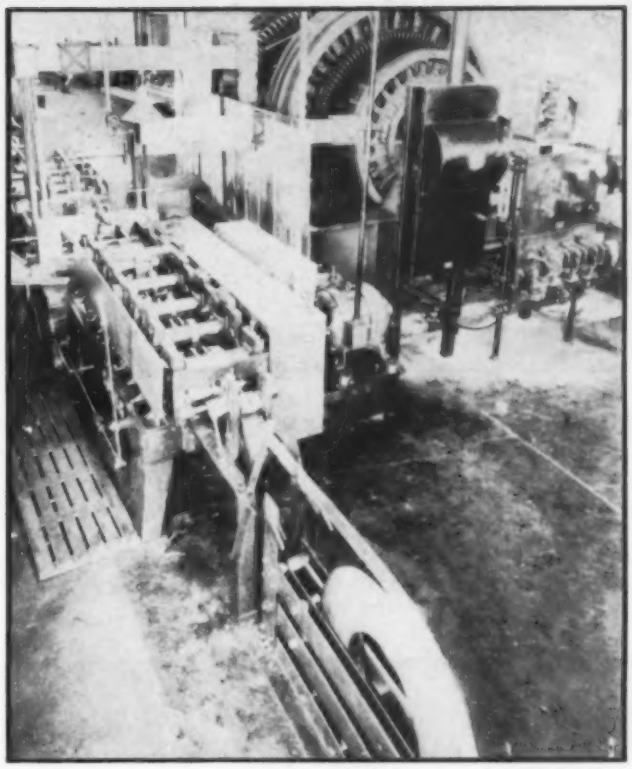


**Figure 9 — Tube welder of d-c type, with its generator.**

▲

**Figure 10 — Modern electric weld tube mill for the production of ¼-1¼ in. tubing with wall thicknesses of .015-.050 in.**

**Figure 11 — Forming end of a large mill with a size range of 6½-24 in. diameter, .25-.75 in. wall thickness.**

Figure 12 — Forming equipment on modern mill designed for diameters of 1¾-6⅝ in. and wall thicknesses of .109-.375 in.

▲

Figure 13 — Another view of the mill in Figure 12, showing welding unit and sizing mill.

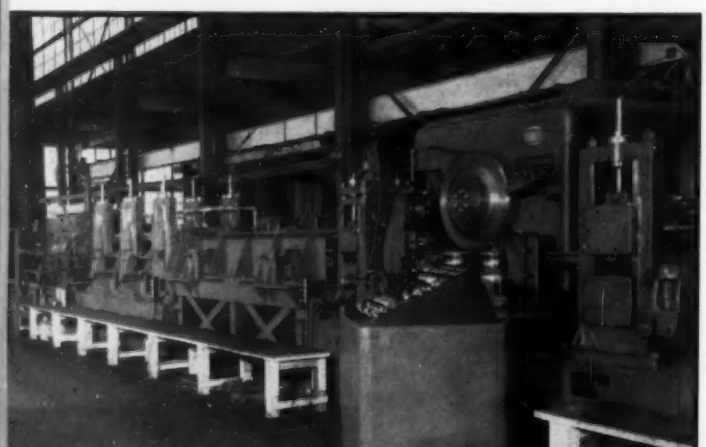
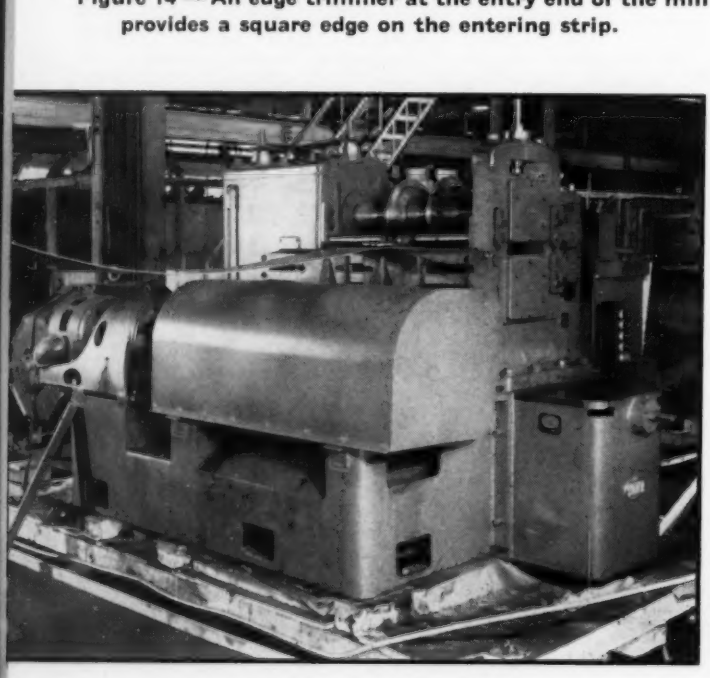


Figure 14 — An edge trimmer at the entry end of the mill provides a square edge on the entering strip.



the low voltage current from the generator into the revolving electrodes. The overall efficiency is not as good as that obtained with a-c. The general market, however, is not quite ready for speeds as high as can be obtained with d-c current, as handling equipment is not yet perfected. We believe, however, that electrically welded tubing at speeds of 400 fpm will be available in the future.

Complete standard lines of tube mills have been developed covering the range from ¼ in. to 26 in. outside diameter with wall thickness ranging from .015 in. to ½ in. or heavier. Figure 10 shows one of the smallest units, with a size range of ¼-1¼ in. outside diameter, while Figure 11 shows the forming end of a mill that makes up to 24 in. tubing.

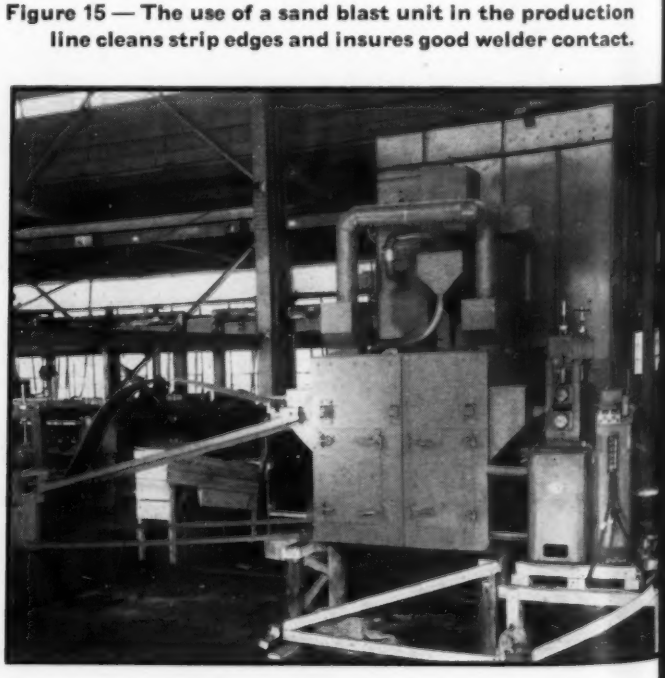
The size ranges of the available mills overlap considerably. The most efficient tube sizes are in the middle and upper diameters of the mill size range. The mill designed to produce 1½-6⅝ in. diameter pipe will not produce 1½ in. tubing as economically as the mill designed to produce ¾-4 in., due to higher tooling and handling costs. The required wall thickness, however, is the real indication of the size mill required.

Two mills, with a range of 1¾-6⅝ in. diameter, .109-.375 in. wall thickness and originally built for export, were, upon completion, taken over by the Government. One was put into operation in our own plant, while the second was diverted to one of the steel mills. Both mills have been producing 6 in. invasion pipe which has played an important part in the invasion of Europe and the Pacific islands. We have produced more than ten miles in a 21 hour day.

Figure 12 shows the tube forming equipment of these mills, while Figure 13 shows the welding unit and sizing mill.

Although this invasion pipe has only ⅛ in. wall thickness, it is subjected to a hydrostatic test of 900 psi as a production test during inspection and stands a bursting test of from 2200 to 2500 psi. Scrap losses of less than 1 per cent from all causes have been recorded day in and day out on final inspection.

Figure 15 — The use of a sand blast unit in the production line cleans strip edges and insures good welder contact.



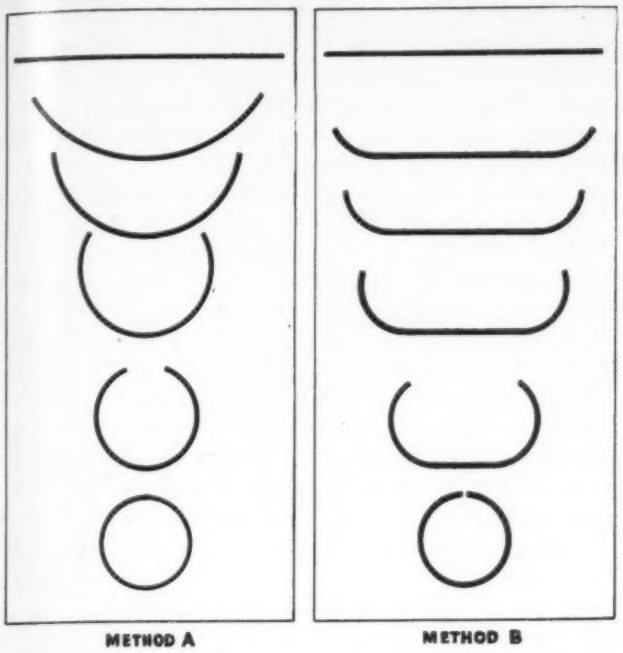



**Figure 16 — Progressive steps in forming. Method A is for small sizes and light gauges, method B for larger diameters and heavy gauges.**

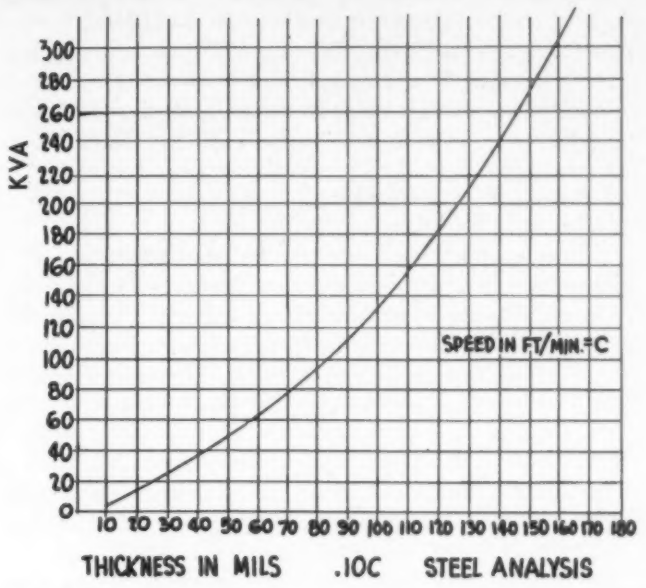
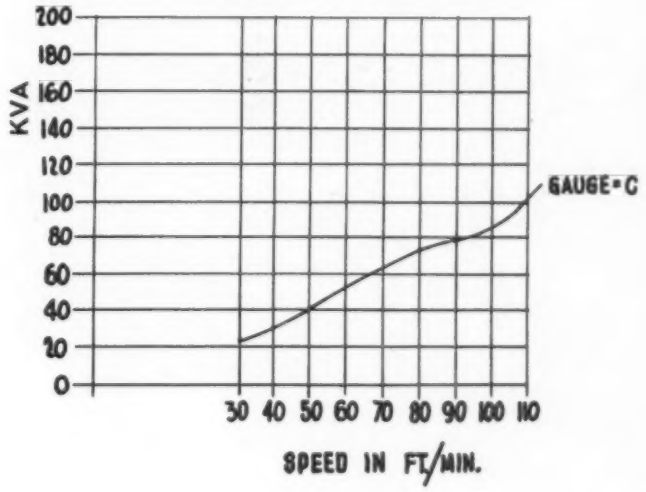



**Figure 17 — Curve showing variation of kva input to welder for various gauges (speed constant).**

A

**Figure 18 — Curve showing variation of kva input to welder for various speeds (gauge constant).**




When originally designed, these mills were to produce finished pipe from hot-rolled, unpickled, mill-edge strip in coils. To provide a clean, square edge we provided a trimmer as shown in Figure 14. Utilizing a continuous sand blast to clean the edges for welder contact, and loosening and removing scale during forming, a tube was produced with appearance very nearly approaching that of a tube made from pickled strip. Figure 15 shows the sand blast unit as a part of the line.

When we think of electric-weld tube mills, we are often inclined to overlook one of the most important items in the successful operation of such a mill — that is, the forming of the strip into the tube. If the tube is poorly formed, it will not make good tubing. Careful roll design and careful adjustment are of prime importance. We ordinarily use two types of rolls for forming tubing. One design is used for tubing of fairly light gauge up to 4 in. in diameter. The progressive steps with this design are shown in method A, Figure 16. For larger diameters and heavy gauge, we use a patented design of rolls which give progressive steps as shown in method B. It is apparent that the initial forming process is quite different from the first type. One safe rule to follow is do not use too few forming roll passes.

Materials suitable for making good electrically welded tubing can vary considerably without causing difficulties. The easiest material to weld is SAE 1010 or 1020 steel, either cold-rolled or hot-rolled and pickled. Steel with a carbon content up to .60 or .80 have been successfully welded. High sulphur and high phosphorus are not conductive to good welds. Many alloy steels, such as SAE 4130 airplane type steel, weld satisfactorily. Stainless type steels are hard to weld with either a-c or d-c resistance methods. Hot-rolled steel is welded perfectly by passing the strip through a sandblast cabinet and cleaning the edges prior to its entering the forming mill rolls. This cleaning should cover enough strip width along the edges to permit good electrode contact. The operation is done on the fly as a part of the tube mill operation.

Good electrode contact is necessary for good welding. If the tube is not properly formed, it is impossible to get good contact. The amount of electrode contact on the tube is important. However, too much contact has the effect of heating too much of the tube and making too wide a heat line. There is, however, a very detrimental effect from too small an electrode contact, which can be easily noted immediately upon starting a weld. Whenever too small a contact prevails, small burn marks develop in the weld zone and in most cases, if continued for several revolutions of the electrode, copper deposits will develop on the surface of the pipe during welding.

While operating under these conditions, the weld

will be brittle and the welded metal will be noticeably dark in the weld zone, and when the weld is subjected to a high pressure hydrostatic test (60 per cent of yield stress), it will show many leaks. Continued operation under these conditions will break down the electrodes about four times as fast as normal. Since electrode cost is directly reflected in the overall production cost as a sizeable item, it is important to reduce the wear of these parts to a minimum.

It is apparent that, for small diameter, heavy wall pipe with ratio of thickness to diameter of 10 per cent or more, electrode contact will of necessity be reduced as compared to the same thickness with a larger diameter. This of necessity increases the amperes per square inch, thereby concentrating the heat over a smaller area. In these cases, the life of electrodes will be shorter.

Much time has been given to investigation by power companies to determine the power factor change due to installation of a machine of this type in a new plant, and in every case results between 88 and 96 per cent have been recorded as the overall power factor of these welders. Special attention to the design of the conductors and other parts of the electrical system to reduce impedance in the low voltage circuit has contributed largely to this higher efficiency.

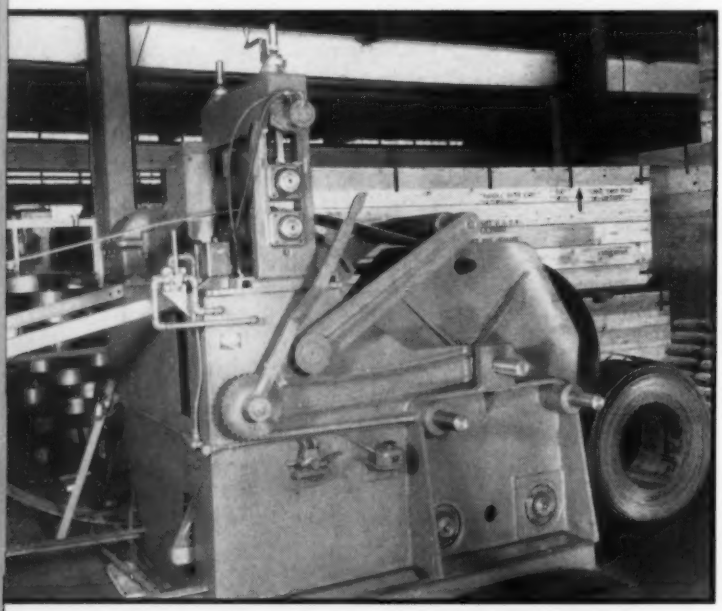


**Figure 19 — Automatic coil box for heavy gauges, which grips the strip and end feeds it into the rolls.**

▲

**Figure 20 — Flying cutoff of hydraulic type, which has given good results with relatively little maintenance.**

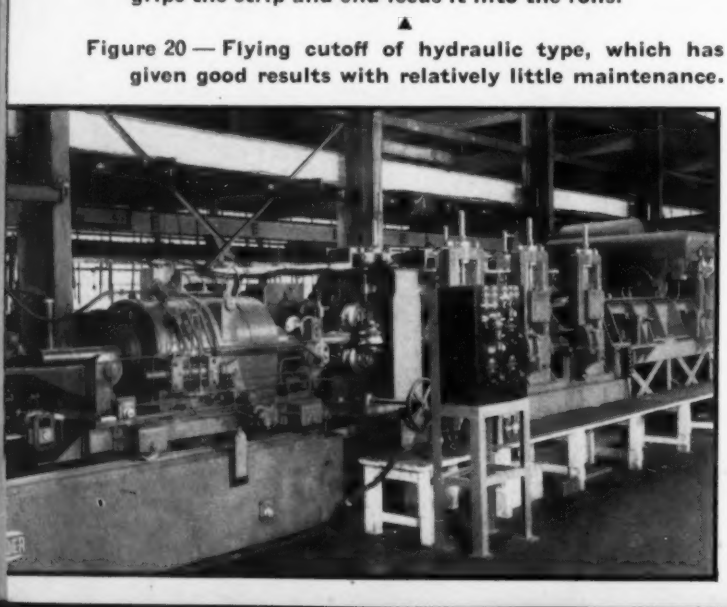


Figure 17, showing input kva for various steel thicknesses, indicates the influence of this variable on the size of a welder. Speed is a constant in this chart in order to study gauge influence as an independent item. Figure 18 shows the input kva as compared to speed change on a particular gauge. It is apparent from these charts that gauge increase has a greater influence on kva requirements than a proportional increase in speed.

Another important item is the handling of coils at the entrance of the tube mill. This particular factor will largely govern the percentage of capacity production at the end of the day. The coils can either be fed to the mill individually or, with the ends of the coils welded together, continuously. The process of butt welding the ends of coils while a loop of strip is thrown out on the floor is well known. This process is conducive to very high production, but it incurs expense for equipment and a layout of floor space that is not always available. To offset this, we have incorporated a feature known as self-threading, which permits continuous operation of the mill without slowing down to introduce each new coil. An automatic type of coil box (Figure 19) is required for heavier gauges which grips the end of the strip and feeds it into the rolls in the mill. The mill is arranged so the end of the strip will automatically thread itself through all the rolls at actual welding speed. On this basis, the entering end of a new coil is only 10-15 ft behind the trailing end of the old coil. With this type of equipment, 50,000-60,000 ft of tubing per day can be produced.

After the tubing is formed, welded and sized, it must be cut off on the fly. This is a simple matter on small mills, as a flying shear type cutoff cuts to accurate lengths as the tube passes through. Larger sizes require much more complicated rotary type machines which either cut the pipe with parting tool type cutters or with rotating discs. Such a machine must be rugged but not so heavy that it cannot be reciprocated back and forth as the cuts are made. After building many different types, we have decided that the all-hydraulic type cutoff does the best job with less maintenance. Figure 20 shows this type.

Runout tables, dump tables, turks heads, straightening devices, trimming devices, cooling troughs, guides, drive methods and many other items also play an important part in every tube line.

One other matter of general interest is the cost of producing electrically welded tubing. Skelp price will of course vary for every size of tube. The small mills producing up to 2 in. diameter can be operated by one man. Most plants, however, find it more economical to use two men. Mills turning out sizes up to 4 in. should have two men and mills larger than 4 in. should use three men.

To this, maintenance and depreciation of the mill must be added. We could well say that the cost of electricity might be almost disregarded, as the cost per foot for 4 in. tubing with ¼ in. wall thickness is $0.001. Lighter gauge tubing would be considerably less. Generally speaking, electrically welded tubing can be produced for less than seamless tubing of the same size, and with an initial investment of less than one-fourth. It is our belief that the butt-weld mill of the old type is going out fast. Three types of mills will produce all

of the pipe and tubing. These are electrically welded, seamless and Fretz-Moon welded pipe.

The facts we have at hand would indicate that there are certain sizes and gauges under 4 in. which can be produced cheaper on Fretz-Moon mills. Other sizes and gauges can be produced cheaper on the electric weld mills. As a proof of this, we might point out that Republic Steel Corporation, who are co-owners of the Fretz-Moon patent, operate both types of mills. We believe each type has a field which it can best fill.

In making a survey of the industry, we find that the tube or pipe made by these three processes (electric weld, seamless, and Fretz-Moon) each has its own application. Each process produces a different type and quality of product, but we cannot lose sight of the fact that each year electric weld tubing and pipe replaces more and more of the product made by the other two processes in the overall world wide market.

The production of electrically welded tubing is a fast-growing industry. The building of mills for this type of production is an ever-changing program. Mills may be similar, but are never exactly alike. Something new is being added every time one is built.

# DISCUSSION

PRESENTED BY


L. J. HESS, Superintendent Pipe Mills, Bethlehem Steel Company, Sparrows Point, Maryland

H. L. WATSON, JR., Superintendent, Special Products Department, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

R. H. STEVENS, Chief Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland

J. H. BUCKNAM, Assistant Superintendent, The Linde Air Products Company, Newark, New Jersey

JOHN LUCAS, President, The Yoder Company, Cleveland, Ohio


**L. J. Hess:** I realize that Mr. Lucas' subject covers too much territory to be detailed in one paper. It is not a simple subject. There are many complications in connection with it, and any number of these require the earnest study of both electrical and mechanical engineers.

I well recall in the days when Republic Steel Corporation first started to work on their electric weld mills. They went through much grief, as might be expected. They finally came out with what is universally known in the trade as a fine product. There is no question but that there is a definite field for each of the three types of pipe, although these fields do definitely cross. There are some sizes and weights of pipe which can be made by any one of the three processes, depending upon the service for which the pipe is to be used.

I think Mr. Lucas was right in his statement that there is a growing demand for electric welded pipe. Like all new products, it takes a certain amount of time to overcome the resistance of people who for many years have used one thing, and don't believe there is anything better. However, I think the electric weld people have done a remarkably fine job in overcoming this resistance, and today those of us who are in the pipe industry realize that we must continue to move forward and adopt these things which are coming out as a result of engineering developments.

**H. L. Watson, Jr.:** What dictates the choice between forged steel and cast forming rolls?

**L. F. Coffin:** In view of the fact that I presume the edge trimming squares up the edges, the subsequent forming will produce an opening between the two edges of the skelp that is not parallel and is also sprung open considerably. Will such a condition on thicker wall material appreciably produce residual strains to be left in weld?

**R. H. Stevens:** Is there a definite relation between the width of skelp and the distance required to do the forming? The edge forms a spiral which is necessarily longer than the center of the skelp which is not deformed. If this edge is stretched beyond the elastic limit, will it be buckled after forming or is this compensated for by having special physical characteristics in the skelp?

**A. J. Fisher:** What is the fuel rate on these electric mills when you go back to the coal pile for your electricity, as compared with the continuous butt weld mills?

**J. H. Bucknam:** I assume that the welds are like most resistance welds and normally have a flash on the outside and inside. Mr. Lucas explained how the flash is removed on the outside; I am wondering how it is removed from inside.

Also, when the tubing is sized and rounded, is any attempt made to smooth up the inside of the pipe after the flash is removed?

**John Lucas:** The question regarding cast or forged steel rolls is rather hard to answer definitely, due to the fact that both types of steel are widely used for this particular purpose. We have used both types and still use both types.

On the larger type mills we are more inclined to use cast rolls. We can get them cast fairly close to shape out of alloy steels that resist wear very well, and the cost of rolls in the larger sizes made from castings is usually somewhat less than if we used forgings. On smaller mills, we still use forgings in almost all cases. We find, however, that there is quite a difference in the types of steel from which we make rolls. Some rolls are made from just ordinary straight high carbon steel. The disadvantage of making rolls of that type steel is the fact that they have a tendency to warp considerably in the hardening operation and require quite a bit of grinding to get them back into shape.

In the smaller mills we use quite a lot of an oil-hardening alloy steel which before the war contained a fair percentage of nickel, but which now does not contain much nickel. The oil-quenching steel wears well and distorts very little in the quenching operation, and the grinding is kept at a minimum.

The greatest abrasive action is encountered in the large rolls where the grooves are deep. In the roll that covers one-half of the pipe diameter there is only one point on the groove where there is rolling action. At all

other points there is sliding and, of course, friction and wear. By using what is ordinarily termed high carbon, high chrome steel for that type of roll, we get much better life.

The gap left in the tube as it comes from the forming mill, if it were allowed to expand, would vary almost directly with the hardness of the steel or with the carbon content or some other characteristic the steel might have. In low carbon types of steel, there is very little gap because we iron the metal pretty thoroughly as it goes through the mill. As it comes up to the welder there is very little gap. But as you get into the higher carbons and harder steels there is quite a considerable gap. In fact, in some sizes we would get a gap maybe as much as 30 or 40 degrees, but the tube is not allowed to open up to that point. As it comes through the last forming rolls, it is completely surrounded both top and bottom, and so is held to its exact size. It is held to that position until it goes into the welder and under the electrodes. As it goes under the electrodes, and heating occurs, there is a pair of side-squeeze rolls that bring the edges in, squeeze the molten metal so that we get some flash on the inside and some on the outside, and hold it in that position for quite some little distance beyond the welder, until it cools to a point where there is no tendency to open up the weld.

In other words, the steel has hardened sufficiently so that it has strength to hold itself in shape. Thus there is actually no stress in the weld due to the residual strain in the tube at the time it is formed. In forming that pipe, tensile strength is increased to a considerable degree because of cold working. The increase depends on the analysis of the steel, but it is very noticeable. We can pull a test bar from flat stock and another test bar from a formed tube, and there is quite a noticeable improvement in the tensile strength of that steel.

Mr. Stevens' question regarding stretching the edge of the strip beyond the elasticity limit: He mentioned also about mill edge of the steel — where we have a mill or rounded edge, we trim that steel. That rounded edge is trimmed off and we get a square edge before we start the forming operation, and in forming our tubing, we do bend it beyond its elastic limit, so that it stays put when it is brought up to the point of welding.

No special characteristic of steel is required as regards hardness. Tubing can be formed from dead soft stock or from full hard, cold rolled steels. The hardness of the steel going in must be governed by what you want to get out. If you want a real soft pipe you must feed in a soft strip. If you want a stiff, hard product, you will use a harder strip. Any of the grades of hardness that are commercially produced can be formed and welded into good tubing.

In a greater part our mills have been installed in plants having power supplied from a large commercial station, so the conversion of current cost to tons of coal used is quite difficult.

Mr. Fisher is probably interested in a comparison between electric weld and Fretz-Moon processes as far as coal consumption per 1000 foot of tube. While we do not have such a figure available, we do know that some sizes of tube on both processes show an advantage over the other. This also occurs between seamless and Fretz-Moon so unless actual sizes are considered it is difficult to make any general statement.

Mr. Bucknam asked about flash inside of the tube. That is a problem that has caused a lot of headaches. It is particularly bad on the small sizes. When you think about getting inside a half-inch piece of tubing and taking a flash out, it is quite a problem, but it is now being done very successfully by one of several methods. One of the most common methods is to roll the bead by a series of inside small diameter hardened rollers while it is still in the semi-plastic state. That does a nice job. Nevertheless, on the very small diameters it is pretty hard to get little rolls in the tube that are big enough to have strength to stand up. So there has been developed another method in which there is an inside mandrel tied back in the forming mill before the tube is closed and extending past the sizing rolls. A very fast hammer is mounted at that point, immediately over the mandrel. This may be an air hammer or something similar, so that a continual vibrating or hammering takes place and the flash is pounded down on the inside mandrel.

Then there is the process of using an inside trimming tool. This tool is mounted on a carrier that is tied back into the mill similarly to the mandrel just mentioned, and the cutting tool is placed a short distance beyond the welding point. The flash is trimmed out by a tungsten-carbide tool that takes the shaving out, and leaves it lie in the pipe. As it is cut off, the shaving falls out.

These three methods are in pretty general use, some plants using one, some another, and some using special adaptations of one of the three. There are some patents which govern certain adaptations of some of these processes, so that each mill is a problem of its own, and has to be worked out for the particular size and type of tubing or pipe to be produced.

After the tube is hammered or rolled, we do nothing more to smooth it up in the sizing pass; it is finished when one of these processes is completed. The only thing done in the sizing pass is to bring the tube down to size. In other words, the tube is welded a little oversize and then shrunk slightly so that a uniform diameter is obtained. That diameter can be held very close.

The tube is put slightly out of shape by the pressure and heat of the electrodes; it flattens out a little, but when sized and shrunk to the proper size it is very round and very close to size. That is one thing that can be done on the electric weld mill a little better than in some of the other processes.

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# Electronic Controls

*. . . . development in electronics has led to a constantly widening field of industrial application . . . . maintenance of electronic equipment has been found in most cases to be less than with the older methods . . . .*

*by Frank Roberson*

ASSISTANT DIVISIONAL SUPERINTENDENT OF MAINTENANCE

CARNEGIE-ILLINOIS STEEL CORPORATION

GARY, INDIANA

▲ THE electron tube is the most versatile modifier of electrical energy yet devised. Already it is making possible operation and control formerly considered impossible to attain. Even the slightest variation in any physical, electrical, or chemical quantity will actuate an electron tube.

For example, any change in voltage, current, resistance, or frequency, no matter how small, will cause an electron tube to operate. A change in temperature, light intensity, moisture content, position in space, or weight will initiate electronic operation. Variations in opacity, color, turbidity, acidity, or conductivity will cause an electronic control to function. And further, this functioning is instant, quiet, and efficient, and when desired, regular.

Most people think of electronics as a new field, yet it has made possible radio and sound motion pictures which represent an annual business of half-a-billion dollars. Industrial applications and communication systems will raise this figure to well over a billion dollars. There are tremendous possibilities in electronics. This paper will discuss some of the more interesting applications of electronic controls in industry today, as well as indicate future possibilities.

The average layman or engineer not directly familiar with electron tubes and circuits is mystified by them, but much of this mystery can be dispelled by comparing electron tube performances with those of more familiar apparatus and equipment. Thus, an electron tube may be thought of as a non-mechanical contactor, opening or closing a circuit. It will, however, perform the operation so much faster than its mechanical counterpart that comparison is hardly possible. With a tube, a thousand openings or closings a second is not unusual. No real competitor to the tube exists when really high speed operation is concerned. This is clearly demonstrated in the case of induction and dielectric heating, where the electron tube alone can produce satisfactorily the ultra-high frequency currents required.

Most people have at least heard about smoke recorders, high speed counting devices, television, and sound movies. These are merely applications of the photosensitive electron tube which transforms light energy into electrical energy.

Everyone is familiar with the principle of radio reception, where the electron tube detects extremely weak signals and faithfully amplifies them. Even now in open-wire transcontinental telephone circuits the original voice energy is amplified in 16 successive stages, a total of 1,000,000,000,000,000 times. This amplification can be sufficient to actuate mechanical equipment, thus opening a broad field to the application of the electron tube.

Not all tubes can perform all functions, but some of them can perform several functions, often simultaneously. In combination, a phototube and a grid-controlled rectifier can control a 5 hp motor by the energy of the beam of light from an ordinary pocket flashlight. With the addition of one or more amplifier tubes, the light

Presented before A. I. S. E. Chicago District Section Meeting, February 6, 1945.

from a star so distant that it takes millions of years for the light to reach the earth can be used to shut down or start this same motor.

Still another use of the electron tube lies in generating alternating current from direct current as supplied from a battery. And it will as readily form a million cycles per second as the familiar sixty cycles we now get from mechanical equipment. It may be that this application will be the most important contribution of electronics in expanding the range of human endeavor.

The infinitesimal electron, so small that it has to be imagined rather than seen and calculated instead of weighed, is the basis of electronics. An electron is to the head of a pin what a drop of water is to Niagara Falls, and it has been computed that a pound of electrons would light a 100-watt lamp for 16 years. When we learn how to store electrons as we now store electric current in a battery, an entire new world will be opened to us.

Few operators realize how much power is lost in armature starting resistances and in shunt and rotating-field resistances. It is estimated that in an average steel mill the power dissipated through resistances in crane hoist motors, roller lines, skip hoists and other applications where motors are subject to frequent starting and stopping, amounts to several million kilowatt-hours per year. Much of this present loss will be saved when electronic control has been perfected for application to large motors. At present, its use is only applicable on motors up to about 25 hp.

Stable operation over a much wider range of speeds is another advantage made possible by electronic control. Where a conventional control will give a 4:1 ratio, electronic control will give a 50:1 ratio. With the electronic control this ratio will be stepless, and speed can be held constant at any predetermined rate, within limits, regardless of load and voltage variations. Control of this nature is particularly important in connection with drives for machine tools requiring constant, precise cutting speeds.

In rolling steel billets it is important that water be kept off the corners of the hot steel billet, yet used on the rolls to keep them cool. An "electric eye," or electron tube, takes care of this by automatically shutting off the water as the billet moves in toward a stand and turning it on again as the hot billet leaves the stand.

Only with electronic control can true precision electric welding be accomplished without marking, warping, or scaling of the product. It permits the welding of stainless steels, brasses, bronzes, or aluminum because of its perfect control of every point in the welding cycle. Thin sheets can be welded successfully because of this split-second control. A high degree of precision is necessary in welding of this nature, for the electrode pressure must be relieved sufficiently to prevent thinning the material while it is at welding heat, yet maintained tight enough to hold the welded joint together until it has cooled. During the period when the electrode pressure is changing, the current must flow at exactly the right time, be of the right amount, and continue for the proper length of time. As you know, spot welding is a rapid operation, so it can readily be seen what a high degree of precision is required of the electronic control to achieve results described.

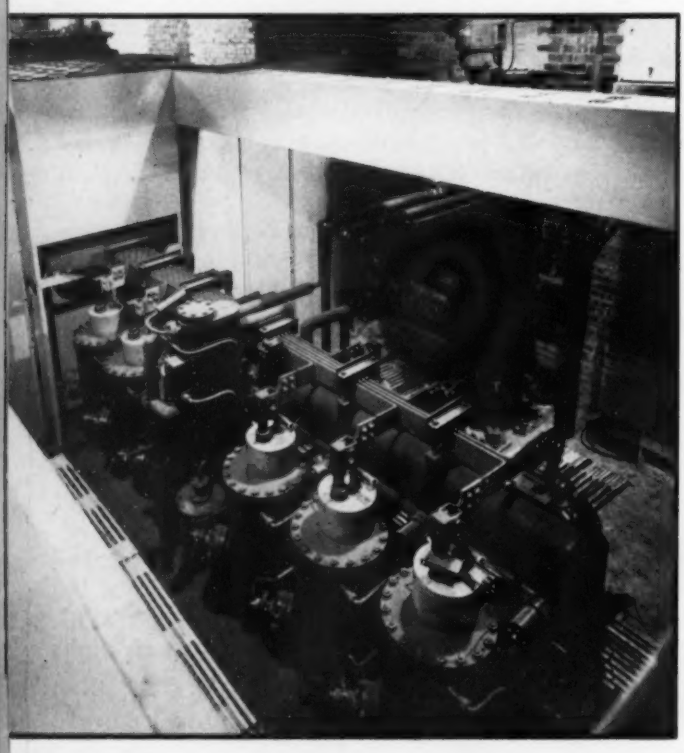
The mercury arc rectifier, which is another form of electronic tube, is being used in place of motor generator sets and synchronous converters in many new installations. In fact, as it becomes further simplified and improved, this unit bids fair to become a serious competitor to the older methods of supplying direct current. There are some who now think that in time direct current will replace alternating current in high voltage power transmission because of the ease of generating direct current electronically. Voltage limits imposed by the conventional commutator do not affect the electron tube, which handles high voltage with even greater ease than it does heavy current.

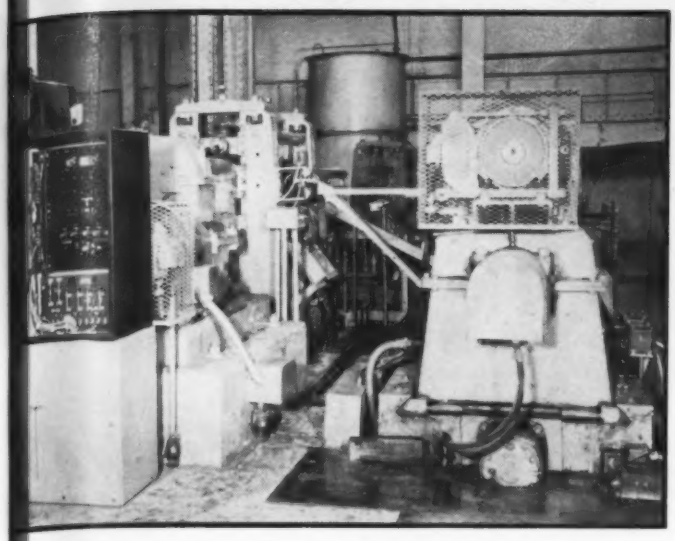
The time is at hand when manufacturers and users of electrical apparatus must rearrange their thinking because of this new vacuum tube and the magic electrons within it.

Electron tubes are now displacing conventiona equipment in time-delay circuits. By the simple variation of grid voltage in an electron tube, current can be made to flow at will in larger circuits, thus actuating mechanical relays and contactors. The fact that there are no moving parts in an electron tube to be affected by temperature changes, mechanical wear, or climatic conditions gives electronic control a big advantage over mechanical timing.

The electronic high-frequency heater produces results that cannot be duplicated in any other way. It converts ordinary 60-cycle power into high frequency (550,000 cycles per second) current, making it possible to heat objects in ways that could not be accomplished with lower frequencies. Induction heating at 1000 cycles or less has been known for some time. Motor generator sets have produced up to 15,000 cycles per second; spark-gaps further increase the range up to 200,000 cycles. Recent developments in induction heating, however, require frequencies above 400,000 cycles per

**View of 1500 kw, 250 volt mercury arc rectifier inside a removable enclosure. This is part of a unit substation serving a large maintenance shop installation.**





**The panel at left provides control for tension rolls, idler roll, scanning head and winding reel, as well as side-register control, at the delivery end of an electrolytic tinning line.**

▲

**This automatically timed induction heating and quenching unit for small gears uses a 15 kw electronic heater.**

second and such frequencies can only be supplied by electron tubes.

Induction heating is now quite widely used for heating gear tooth faces which must be hardened without distortion of the gear. In such an installation a load coil, consisting of several turns of heavy wire, is fitted closely around the piece to be heated. The turns of this coil act as the primary of a transformer, while the gear acts as a short-circuited secondary of the transformer. Because of the high frequency, the induced current has a tendency to follow the contour of the gear teeth ("skin-effect"), thus concentrating the heat near the surface. Thus, when quenched, the desired surface hardness will be developed on the teeth without affecting the toughness of the body.

Electronic controls are just as adaptable to heavy industry as they are to microscopic quantities, as will be seen from the following list of applications to present day problems:

1. Radio-frequency heating of tin plate and detection of pin holes thereon.
2. Air-cleaning, wherein air particles as small as 1/250,000 of an inch are removed.
3. Photo-electric grading by color and size.
4. Automatic temperature controls.
5. Motor control and speed regulations.
6. The electronic frequency changer.
7. Metallurgical research, including microscopy.
8. Induction heating of ferrous and nonferrous metals, where it is possible to concentrate 100 kw in one sq in. of surface in a fraction of a second.
9. Dielectric heating of nonmetallic materials.
10. Carrier current controls.
11. The photo-sensitive cell which has both color sensitivity and brightness sensitivity.
12. "X-ray" radiation and detection of defects in large castings or forgings.

These and numerous other recent developments based on electronics now challenge us to gain a better and somewhat revised understanding of this great subject in its relationship to industry in all its branches.

The question of maintenance of electronic equipment has been raised by some, with regard to training the new personnel required and the cost of keeping the apparatus in good operating condition. We have not found it difficult to get men who can handle complaints on our electronic equipment, which is for the most part mercury arc rectifiers, temperature control equipment, and machine tool drives.

As to the cost of maintenance of electronic equipment, we find that in most cases it is less than with the older methods, because vibration does not cause as much trouble in maintaining calibration, and temperature changes and climatic conditions do not interfere as much in the tube installations.

With the war over, thousands of boys trained in electronics will come back to industry, ready to lead the way toward increased usefulness and expansion of this magic arm of science.

WANTED: Architectural, mechanical, structural and electrical draftsmen. Men experienced in steel mill construction preferred. Have openings for detailers, designers and checkers. Write, Engineering Department, Great Lakes Steel Corporation, Ecorse, Detroit 18, Michigan.

# SOME DEVELOPMENTS IN

# *Oxyacetylene Applications*

***. . . many applications of the oxyacetylene process, developed under stress of wartime production, will effect marked economies in postwar production . . . .***

*by G. E. Bellew*

AIR REDUCTION SALES COMPANY

NEW YORK, NEW YORK

▲ THE oxyacetylene flame has long been used for various purposes in the iron and steel plants and in foundries. However, under the impact of the war, new and more extensive applications have been developed on a scale that would have been inconceivable a few years ago. Doubtlessly, many of these practices that were born of the emergency will continue to exist and in turn give birth to new and further developments.

These new processes have been used in the processing of products under manufacture and in the repair of broken and worn equipment. During the period of introduction of the new developments, there was a noticeable hesitancy to take full advantage of the economies offered by these oxyacetylene processes. This reluctance was the resultant of several deterrents, of which the outstanding one was the apprehension that, in the long run, these innovations might prove less satisfactory than the established methods and that structural changes might be effected in the surface regions of the steel.

Studies made by two organizations of unquestioned reliability have done much to overcome this uncertainty, particularly in regard to the scarfing and gouging processes. The first of these was made in the metallurgical laboratory of a large steel company under the direction of two highly qualified metallurgical engineers. The object of the study was — in the words of the report — "a direct comparison of the product of the chipped billet with the scarfed billet on the same heat." Care was taken in the selection of the specimens so that the results obtained would be of significance in indicating the degree of "scarfability" of a wide range of various steels. Tests were run on the following steels:

| | |
|---|---|
| One carbon | SAE 1040 |
| One free-cutting | SAE 1115 |
| One special free-cutting | SAE T-1335 |
| One nickel-chromium | SAE 3145 |
| Three molybdenum | SAE 4130, 4135 and 4640 |
| One chromium | SAE 5140 |
| One silicon-manganese | SAE 9260 |

After careful and thorough study of the action and results of the scarfing of billets of these steels, the conclusion of the report was stated as follows:

"In comparing the surfaces of the finished size of the product of chipped, cold and hot scarfed billets on the tested types and heats, the inspection department claimed all surfaces to be good."

Since this study was made, the steels, that have been scarfed with complete success include carbon (1.02 C), high manganese (1.90 Mn), nickel-chromium (3.55 Ni, 1.20 Cr), carbon-molybdenum (.60 Mo) and chromium-vanadium (.19 V).

Presented before A. I. S. E. Birmingham District Section Meeting, November 20, 1944.

The second study referred to was made on the oxyacetylene gouging process, and was conducted by the material laboratory of the New York Navy Yard. The object of the study was — in the words of the report — "to determine the application of the oxyacetylene gouging torch for the removal of defective metal from steel castings, particularly in the following respects:

(a) . . . . when such defects have been disclosed as a result of radiographic examination.

(b) . . . . whether the flame gouging process leaves the base metal in a satisfactory condition for welding without the need for additional treatment.

(c) . . . . whether the process produces warpage when large quantities of metal are removed locally.

(d) . . . . any tendency for the torch to weld or close up defects."

Upon completion of this very thorough study the following conclusion was issued by the laboratory:

"Oxyacetylene flame gouging is an effective and rapid method for the removal of defects from defective class B steel castings.

"Oxyacetylene flame gouging has no detrimental effect on class B base metal.

"Flame gouged surfaces may be welded without any preparation other than removal of surface slag with a wire brush.

"Within the scope of this investigation, flame gouging did not produce measurable distortion. Oxyacetylene flame gouging does not tend to cover over or conceal defects that may be very easily done by chipping or grinding. In this respect it may prove equal to or even superior to other mechanical methods such as chipping, dulling or grinding.

"It is recommended that the use of oxyacetylene flame gouging torch in connection with the salvage of defective class B steel castings be authorized."

In a manner similar to that of scarfing, the range of steels that can be gouged has been steadily expanded through the experimental efforts of the Navy Department and private concerns; subsequent information on the results of these studies will be released as determined by new data and war conditions.

There were several, distinct factors that produced conditions that required new techniques and a wider utilization of oxyacetylene processes. The problems faced were the ones constantly harassing industry during the earlier stages of the war production program — unceasing, urgent demands from the armed forces for greater and greater production, the ever-mounting shortage of manpower, the critical material shortages that made expansion of facilities impossible, etc. A case in point, basic as well as typical, was the problem faced by the foundries. After eventually getting the plants keyed up for maximum production, it was found that the limiting factor on overall output was the capacity of the finishing of the castings. After giving due consideration to every possible means of overcoming the problem, the foundrymen turned in nearly all cases to the newer oxyacetylene processes. These new methods not only brought finishing output up to the overall production capacity, but also cut manpower requirements and costs to an extent that they now have been accepted as an integral part of the foundry. The average reductions in costs and time through the use of these processes are as follows:

By scarfing . . . . . 35 to 60 per cent
By gouging . . . . . 75 to 90 per cent
By descaling . . . . . 25 to 70 per cent

In addition to these, savings of from 30 to 50 per cent were made by the replacement of hand cutting by machine cutting in the removal of risers.

By the nature of their work, steel mills have always done a greater share of their own maintenance, construction, and reclamation than have other industries. However, during the national emergency, the imperative need for maximum steel production has imposed new tasks and burdens which produced results in the steel mills parallel to that in the foundries, namely increased dependence upon and utilization of oxyacetylene processes. The result was greater and greater employment of welding, cutting, scarfing, gouging and

**Figure 1 — Scarfing 6 in. x 6 in. billets (SAE 4130) in billet conditioning yard.**

▲

**Figure 2 — Cutting riser from large casting by portable oxyacetylene cutting machine. The casting at the top is separated from the riser ring at bottom by a smooth, even cut requiring little finishing.**

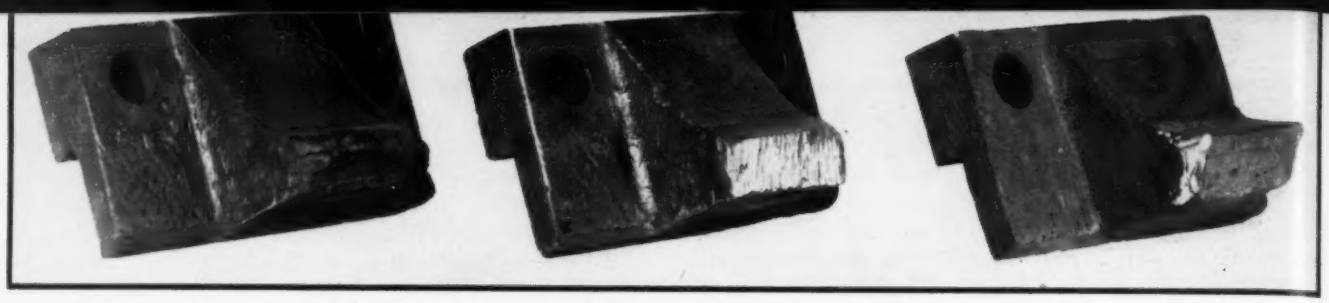


**Figure 3 — Ingot stripper bits. At left, as removed fromservice; center, scarfed ready for welding; right, as built up with heat and wear resistant weld metal.**

descaling operations in order to prolong the useful life of irreplaceable and over-worked equipment. Where once a welded repair was made because it was the most economical practice, similar reclamation jobs now are made because there is no practical alternative. The economic aspects of such applications of welding are — for the present — of secondary consideration, but the past perfection of the numerous welding and brazing processes, as they apply to steel mill problems, is indeed welcome now when these processes are most needed.

One of the most important aspects of the problem lies in the fact that far greater progress has been made, and more knowledge acquired, over the short span of the last few years than could possibly have been accomplished during many more years of normal operation. Much has been learned, for example, about the proper design of assemblies for welding to give them the required structural strength and yet conserve critical materials. Likewise, there has been a broadening of experience in the proper selection of materials for welding and of the welding material, both in the fabrication of new parts and in the reclamation of worn or broken parts.

In these days of forced production schedules and priority ratings, it is absolutely essential that means be available for making replacement parts with a minimum of delay, particularly when the continued operation of essential equipment depends on it. The need for such a part cannot always be forecast, and unexpected failures demand quick action on the part of the maintenance organization.

Indispensable to such maintenance operations is the method of welded fabrication, utilizing standard plate thicknesses and, if obtainable, rolled shapes. The advantages inherent in welded fabrication are numerous, but even if we were granted only its speed and flexibility it would still be a boon to all steel mills. As an alternative to riveting or casting it is advantageous both in requiring a minimum of preparation and in permitting a substantial reduction in weight of the finished fabricated part.

In fabricating replacement parts the first problem to receive consideration is the design of the part. When designing for welded fabrication it is generally desirable to think in terms of a functional unit which will meet the service requirements of the structure, rather than to attempt to duplicate the design of the casting which it replaces. The greater strength of rolled steel permits lighter sections to be used, and where the structure is elaborate, intelligent designing will eliminate finish machining operations which are often necessary if the part is cast but can be avoided when using rolled steel. There are, however, practical considerations which will effect the design of the piece, mainly considerations of time and economy. In quantity or mass production, it is possible to incorporate many cost-cutting features in the fabrication and assembly of parts; however, if the same careful planning is applied to the fabrication of a single replacement part, no appreciable economies are achieved. In most cases the steel mill maintenance department will be called upon to fabricate these parts one at a time; consequently the design should be such that the part can be made as simply and quickly as possible.

Having established the purely functional design as the most practical from the standpoint of both service performance and ease of fabrication, the question still remains as to the best approach to the problem. Generally speaking, it is to use simple sections of steel, positioned to bear the load and broken down into the fewest and simplest sections which can be cut readily from stock plate and rolled shapes.

A special problem is encountered in making a repair or replacement on obsolete equipment. If the original part was a casting, it is not unusual to find that the pattern and sometimes even drawings have long since been discarded. In these cases welded fabrication is the only practical answer, for the fabricated part, regardless of its complexity, can usually be made in the time which would otherwise be necessary for making a new pattern. The diversity of parts which may be made is

**Figure 4 — Bar mill shear blades. At left, prepared for welding; center, welded with hardfacing material; right, after grinding, ready for service.**

endless, ranging from very simple shapes to elaborate structures. Fabricated by welding, the pieces are lighter and stronger than comparable pieces made by other methods, but more important is the speed with which the replacement part can be made ready and installed in service.

One of the most valuable practices of the steel mills in maintaining full-time operation of heavy equipment which is subject to severe service is the process of building up and hardfacing wearing surfaces. This is commonly applied to wobblers, coupling boxes, shafts, piston heads, mill guides, etc. Building up with bronze is sometimes preferable on parts not subject to abrasion, or where wearing surfaces are lubricated. The choice of surfacing material may be influenced by the desirability of transferring the greater part of the wear to the part easiest to resurface, or less costly to replace. Where the wearing effect is very pronounced and must be corrected repeatedly, as with wobblers, it is more economical to build up with weld metal before the part is very badly worn, since less build-up will be required. Further savings can be effected by restoring the worn areas with the part in place where feasible, rather than removing it for the operation.

Another life-prolonging process capable of broad application is flame hardening. Extremely flexible both as to degree and depth of hardness which can be produced, it is of particular advantage in hardening bearing surfaces of machine parts, where only the localized areas subject to wear require hardening. The flame process provides the desired degree of hardness on these areas, leaving the ductility of the core metal unimpaired. A typical application of flame hardening is the reclamation of worn mill rolls, which are turned down to smaller diameters and then flame hardened for use as tension rolls.

In conclusion, perhaps we should bear in mind a fact of very great, as well as universal importance. In viewing the effects of wars, we know that many of the attendant changes never disappear; certainly this recent struggle, which has been called the "War of Technology" or the "War of Machines," will leave its marked effect on our industry. Most of these changes in methods and techniques of industry have been directed toward a single objective — that of attaining the greatest possible production in the smallest possible time at the smallest possible cost of processing. It is evident at once that these are the three dominant factors in the determination of the success or failure of any organization in a competitive, peacetime economy. For this reason, we can be certain that these new processes that have provided methods of increasing production while reducing time and costs will be utilized even more extensively and intensively in this postwar period.

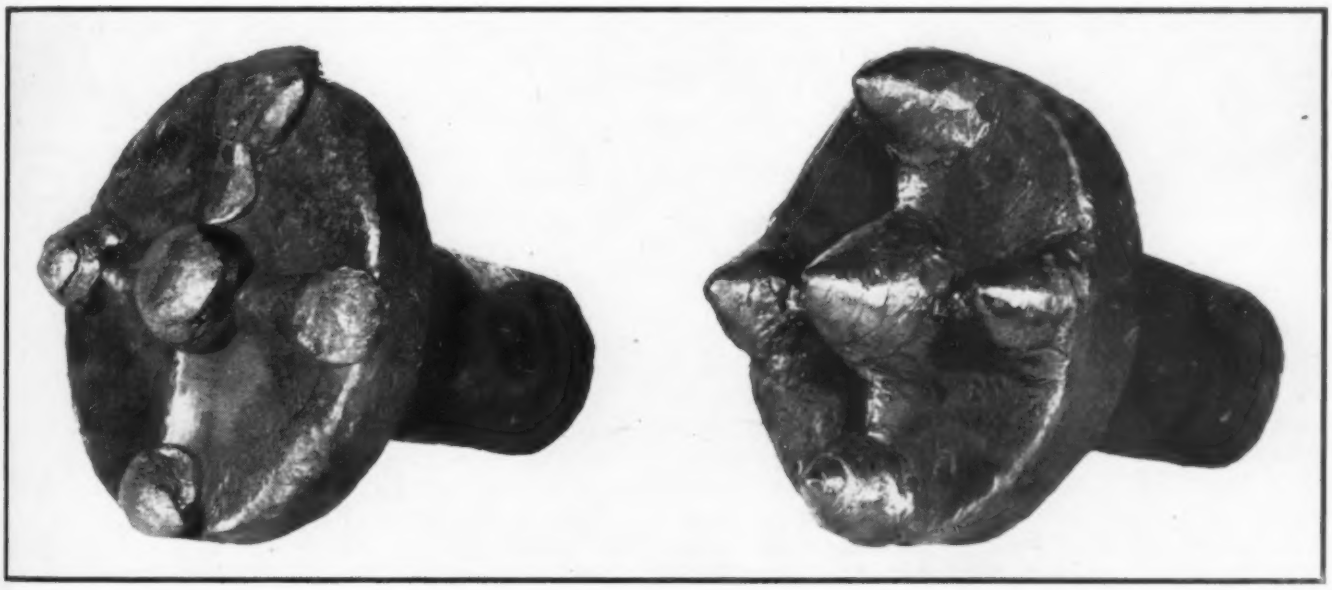


**Figure 5 — Soaking pit tong bits. At left, as removed from service; right, after building up with heat and wear resistant weld metal.**

**Figure 6 — Bar mill guide rollers. From left to right: as machined from low carbon steel; partially surfaced with hardfacing material; after completion of welding; and after grinding, ready for service.**

# Rectifiers IN THE Steel Industry

***. . . . rectifiers show definite advantages for certain applications, and steady growth and improvement can be expected . . . . they should not, however, be selected without evaluating overall economies and merits of each application . . . .***

*by F. Mohler*

ENGINEER, STEEL MILL SECTION

GENERAL ELECTRIC COMPANY

SCHENECTADY, NEW YORK

ALTHOUGH rectifiers have been used rather extensively in the steel mills in Europe for some twenty years, not until 1937 was the first power rectifier, a 1000 kw, 250 volt unit, installed in the industry in this country. Today there are some 60,000 kw installed in the American steel industry. This figure covers only the larger sizes, as we have no accurate record of the smaller sizes. It gives, however, an idea of the rapid acceptance of the rectifier.

Has this swing to rectifiers been sound? What is available in the way of rectifiers today? What are its economics, advantages or disadvantages? What applications have been made, and what are the proper applications of rectifiers? What is the future outlook for rectifiers? These are some of the questions to be discussed in this paper.

Before jumping into the answers to these questions, however, let us review briefly the general fundamentals of the rectifier. It is one form of equipment for converting alternating current into direct current, which is extremely important to the steel industry because it is one of the largest users of direct current. The other common forms of conversion equipment are, of course, the motor generator set and the fast-disappearing synchronous converter. Specifically, the rectifier is a device which will permit current to pass through it in only one direction. Thus, when alternating current is applied, current passes through the rectifier during the positive half cycles, but not during the negative half cycles. There are two general types: the electronic tube type and the dry plate type.

All electronic rectifiers depend upon a flow of electrons from cathode to anode, which will not start, however, until the anode is charged positively with respect to the cathode. Once started, the electrons continue to flow until the anode becomes negative with respect to the cathode which, of course, happens at the end of each positive half-cycle. In a multi-phase rectifier the current commutates from one phase to another, depending upon which anode is most positive.

There are two types of electronic rectifiers in most general use today: The phanotron or thyratron, which depends upon a continuously heated cathode for its supply of electrons, and the ignitron, which depends for the start and continuation of electron flow upon the

Presented before A. I. S. E. Buffalo District Section Meeting, January 16, 1945.

ignition and maintenance of a hot spot upon the cathode each positive half-cycle. The cathode for the phanotron or thyratron is made of a metal from which electrons will flow when it is heated (called thermionic). The tube also has a small amount of mercury in it, which is vaporized by the heat of the arc and this forms a conducting atmosphere which helps it to carry more current. The ignitron, however, is a cold cathode tube. In it a pool of mercury has been found to be the best cathode material for the purpose.

It is largely a question of economics which determines the maximum amount of power which is rectified by thyratrons or phanotrons. Their cathode material is consumed in service, which gives them a shorter life than the ignitron in which the mercury cathode material is self-renewing. Thus, the natural application of the phanotron or thyratron is for relatively small power service, and that of the ignitron for large power service. In order to get the most out of a given carcass all ignitrons are water cooled.

The plate or so-called dry type rectifier merely consists of a series of metal plates stacked face to face, the surfaces of which are coated with copper oxide or selenium oxide. These oxide films have the characteristic of permitting current to flow from disc to disc in one direction only. This phenomenon is also basically electronic, but we need not go deeply into that. It is sufficient for our purpose to know that they do rectify alternating current.

Now let us take a look at what is available today in the way of rectifiers. We start with the babies in the field, the phanotrons and thyratrons. In this class ratings are available from $\frac{1}{8}$ kw to 5 kw at 125 volts, and from $\frac{1}{4}$ kw to 15 kw at 250 volts. Figure 3 shows a 1 kw unit.

We next come to the smaller sealed ignitron rectifiers in ratings from 7.5 kw to 30 kw at 125 volts, and from 15 kw to 60 kw at 250 volts. Figure 4 shows a typical unit rated 50 kw, 250 volts. In the future the two cubicles of these units will be combined in one factory-assembled unit.

Next in line comes the larger sealed ignitron type of power rectifiers in ratings from 75 kw to 500 kw at 250 volts, or from 100 kw to 1000 kw at 600 volts. Figure 5 is a typical 300 kw unit substation, including the incoming line breaker compartment on the extreme left, followed by the instrument and control power transformer cubicle, the rectifier transformer, the rectifier compartment, the control and cathode breaker section, and the feeder breakers.

Looking into the rectifier section (Figure 6), on the left are six ignitrons which are permanently evacuated and sealed metal tubes. In the right hand section may be seen the regulator, which maintains a constant d-c voltage irrespective of variations in load or a-c voltage, and also provides for load balance when operated in parallel with other conversion equipment.

Next comes the pumped ignitron type of rectifier in ratings from 750 kw to 2000 kw at 250 volts, and from 1500 kw to 3500 kw at 600 volts. The unit shown in Figure 7 is a typical 1000 kw, 250 volt, six anode rectifier. Note the rectifier tanks housing the anode-cathode assembly, the igniters, the anode bus connection, the cathode bus connection, the rotary vacuum or roughing pump, the mercury condensation or finishing pump, the

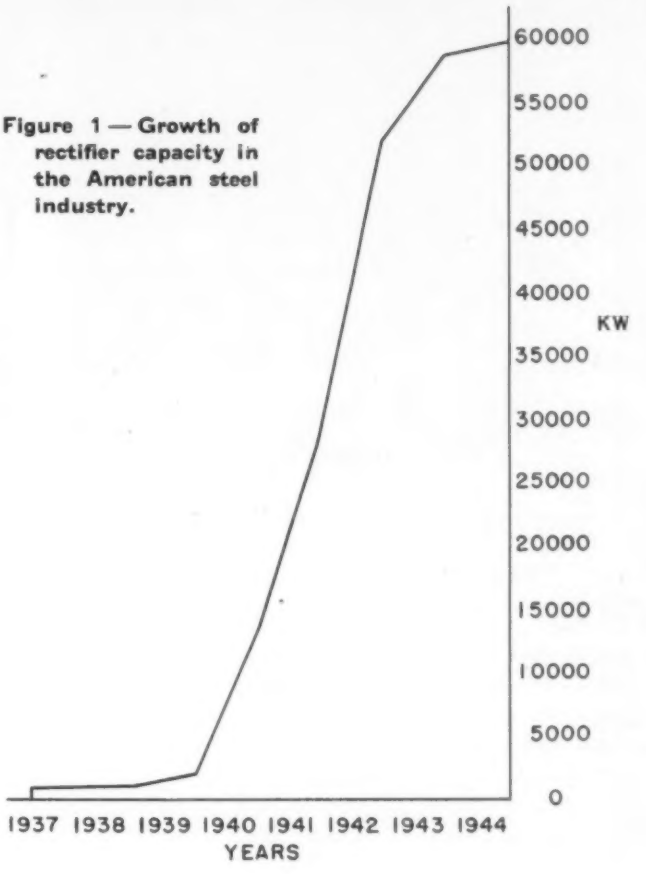



**Figure 1 — Growth of rectifier capacity in the American steel industry.**

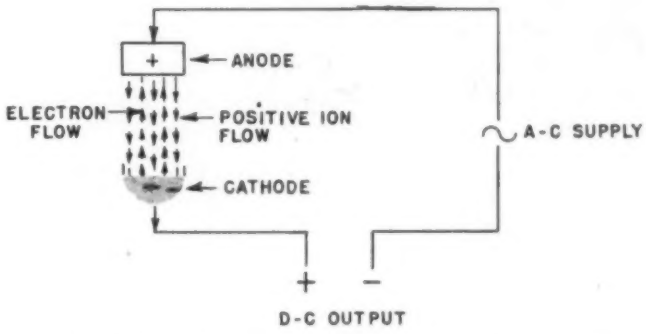



**Figure 2 — Principle of operation of all electronic rectifiers.**

McLeod gauge for accurately checking the vacuum, the exhaust manifold connecting the tanks to the vacuum pumps, the inlet and outlet water connections for cooling the tanks, the supporting base, and the insulators for insulating the rectifier from ground, since the tanks are "hot." This type of rectifier has also been built as a complete factory assembled and enclosed unit.

To complete the electronic picture, although it is not used in the steel industry at present, we have the pumped multi-anode mercury arc rectifier in ratings from 1500 kw to 5000 kw at 1000 to 3000 volts. Figure 8 shows a 2000 kw, 3000 volt unit for railway service. Unlike the ignitron, this rectifier has a hot cathode, which is continuously maintained by an auxiliary excitation anode.

Figures 9 and 10 show a typical stack of copper oxide

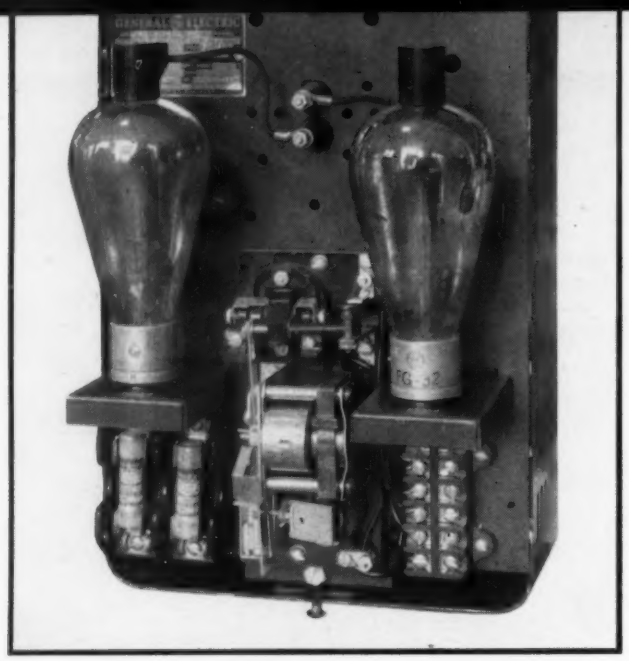


Figure 3 — A typical kw phanatron rectifier.

rectifiers and a comparable stack of selenium units. Each of these is good for about 500 watts on a three-phase connection when force ventilated.

Having reviewed what is available, let us now turn our attention to the economics, pros and cons. Since the rotary converter is about out of the running in the modern mill, this discussion of economics will be confined to a comparison between the rectifier and the motor generator set. It is always exceedingly misleading to assign definite dollars to each of two competing types of equipment because of the myriad variations and modifications which can be applied to each. The answer can often be made to come out any way we desire it. I have no ax to grind one way or the other — I merely recognize that we have two tools with which to work, and one or the other makes sense for a particular set of conditions. It is our job as engineers to weigh all the factors and come out with the proper selection.

The curves which are given here will at least give a general idea as to what can be expected. It should be emphasized, however, that the circumstances surrounding a particular application may upset these relationships completely. In assembling these curves every effort was made to put the complete equipment for either rectifier or motor generator sets on the same basis, and at the same time to follow what is considered good practice in the steel industry.

The set of curves in Figure 11 cover units up to and including 60 kw at 250 volts. It will be noted from the elementary diagrams that electrically the rectifiers and motor generator sets are on a comparable basis. The rectifiers are enclosed, protective covers are used on the motor generator sets, and the control is enclosed. Both are non-ventilated. The motor generator set runs just about $80 more than the rectifier equipments. For 1 kw this is roughly 50 per cent more, and for 5 kw, 15 per cent more. By the mere expedient of using a hand operated thermal breaker for the generator, however, the price would favor the motor generator set slightly.

Above 5 kw the equipment is on almost an identical basis. It will be noted that at 7.5 kw the rectifier is some $90, or 10 per cent less than the motor generator set, increasing until they are about equal at 20 kw, and some $300 or 15 per cent more at 60 kw.

Now let us look at the relative costs of the next larger group (Figure 12). It will be noted the same breakers and arrangements are used for both rectifiers and motor generator sets, and the sets are totally enclosed and equipped with ventilation. For 75 to 150 kw at 440 volts, the sets have induction motors, and are started at full voltage, in which case the costs are almost a standoff. For the 200 to 500 kw sets at 440 volts, however, the motors are of the synchronous type and are started at reduced voltage. Here the rectifier is less expensive by some $2800 or 23 per cent at 200 kw, and 13 per cent at 500 kw. For 2300 volts all the motors are synchronous and full voltage started. Under this condition the rectifier is $300 or 28 per cent less at 75 kw, and only $2300 or 10 per cent less at 500 kw. It is

Figure 4 — A typical 50 kw sealed ignitron rectifier.

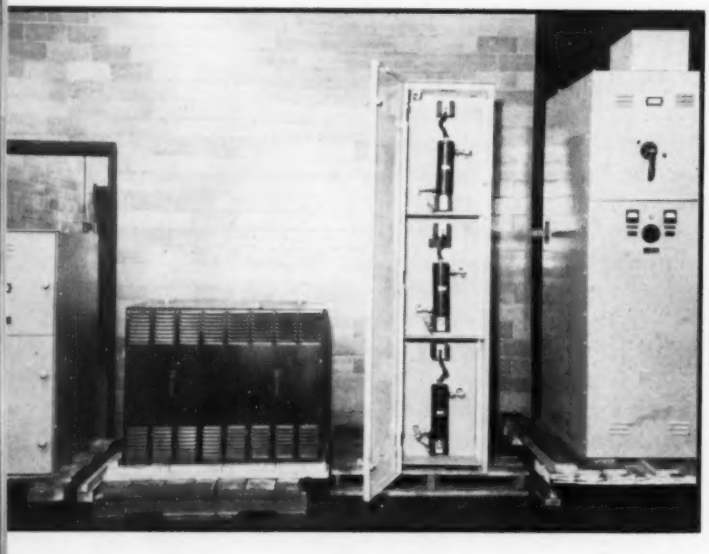
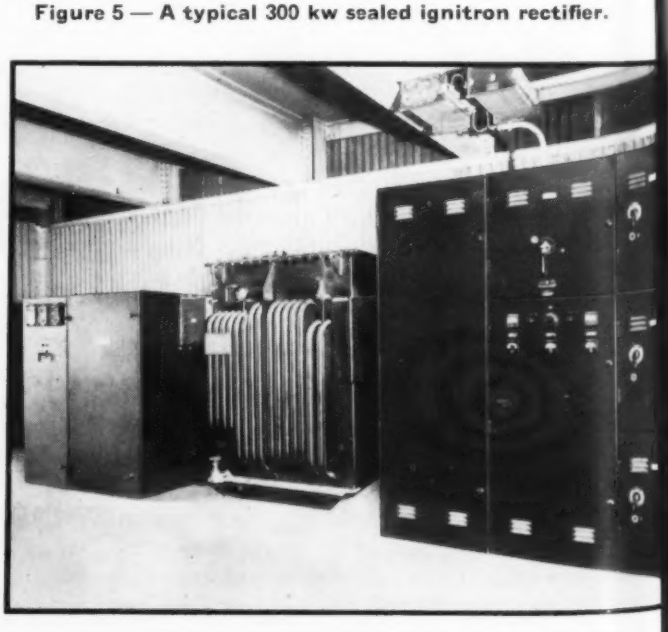


Figure 5 — A typical 300 kw sealed ignitron rectifier.



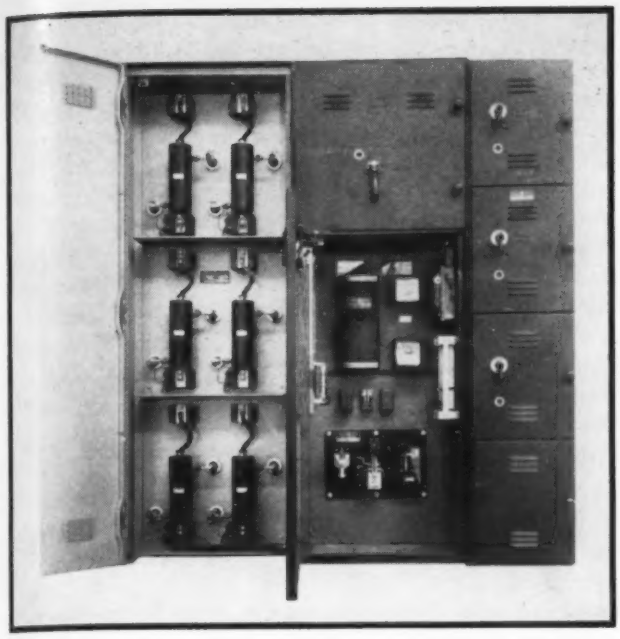


Figure 6 — Internal view of 300 kw sealed ignitron rectifier.

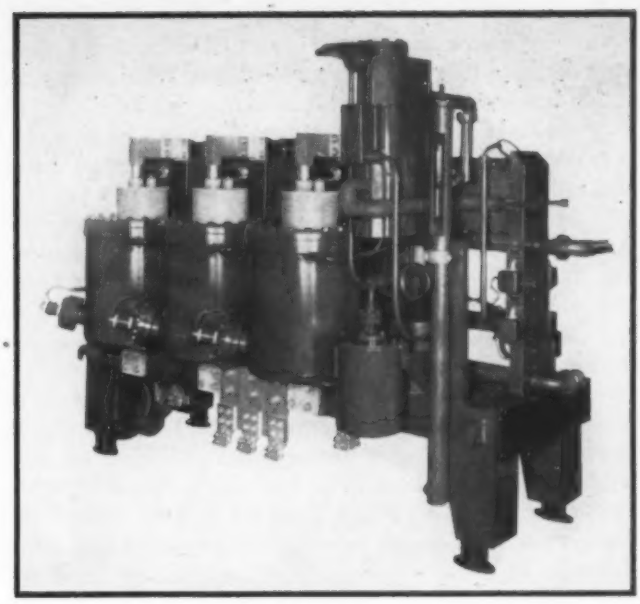
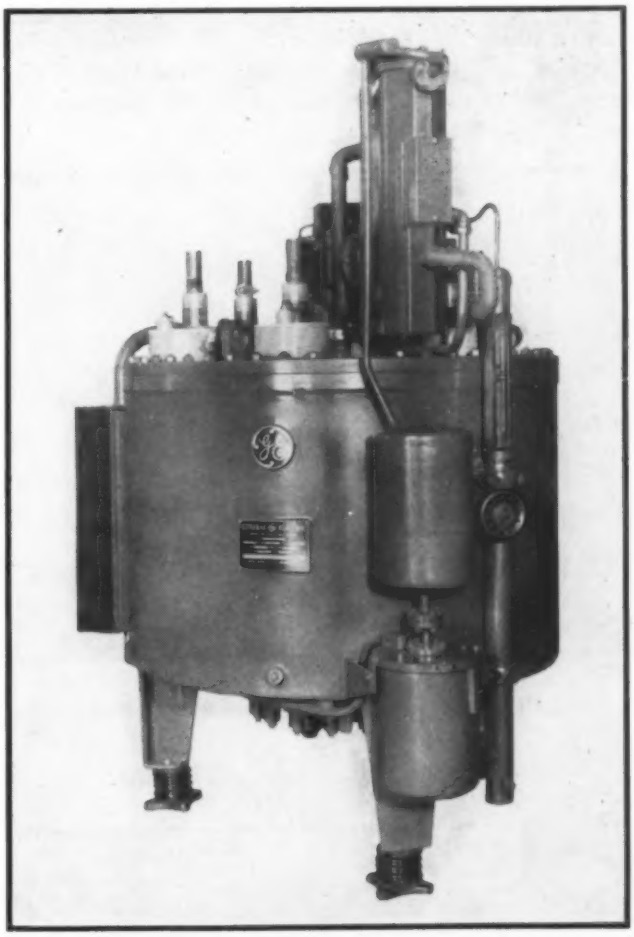


Figure 7 — A typical 1000 kw pumped ignitron rectifier.

Figure 8 — Typical 2000 kw pumped ignitron rectifier for high voltages.



the starting equipment that makes this spread so great for the small units.

Turning to the 250 volt pumped ignitron rectifiers in ratings from 750 to 2000 kw, (Figure 13), the same breakers and arrangements are used for both rectifiers and motor generator sets. The 750 and 1000 kw sets are full voltage started, and above this reduced voltage starters are employed. The rectifiers are water cooled and equipped with water-to-water heat exchangers. The sets are totally enclosed and equipped with recirculating ventilation. Here it can be seen that the rectifier is some $4000 or 11 per cent higher at 750 kw, and $6500 or 8 per cent higher at 2000 kw.

On the other hand, however, it can be seen from Figure 14 that the 600 volt rectifiers are somewhat less expensive than the motor generator sets, amounting to some $4000 or 7 per cent at 1500 kw, and $3000 or 3 per cent at 3500 kw. The comparative equipments are on the same basis as the 250 volt pumped units.

So far we have talked only of the relative economics of first cost of the equipment itself. Other factors, however, may influence the overall decision. First of all, the efficiencies of rectifiers are inherently better than those of motor generator sets. Figure 15 gives a comparison of efficiencies of 250 volt sealed ignitron rectifiers with those of motor generator sets. It can be seen that the efficiency of the rectifier is 91 per cent as compared to 87.5 per cent of the motor generator set at 100 per cent load, and 90 per cent compared to 77.5 per cent at 25 per cent load for 250 volt equipments. For 600 volts (Figure 16) the relative values are 95 per cent as compared to 88 per cent at 100 per cent load, and 92.5 per cent to 78 per cent at 25 per cent load.

We have about the same picture for the pumped units. One important point should be noted from the curves — the efficiencies of the rectifier are relatively much higher at lighter loads than those of motor generator sets. For this reason, a better picture can be gained by looking at the relative losses in kw than by looking at efficiencies. In Figure 17 are shown relative loss curves for a 7000 kw, 600 volt rectifier and a motor generator set of the same rating. It will be noted that the difference in losses amounts to 350 kw at full load, tapering to 260 kw at 25 per cent load. Thus there is almost a constant saving in power in favor of the rectifier for all loads. For any particular application, this

saving in power can be definitely evaluated, depending upon the particular power costs. This can be quite appreciable in a year's time and should by all means be taken into account in any analysis.

The power factor of a rectifier is always lagging, but is rather high when operated at constant voltage, being some 93.5 per cent at 100 per cent load, and 91 per cent at 25 per cent load, for a 6-phase rectifier. Most mills have a considerable proportion of synchronous motors, and usually there is plenty of corrective kva. Therefore, the slightly lagging power factor of the rectifier does not offer any general problem, and is well offset by the improved efficiency for constant potential operation. If voltage is controlled over a wide range, however, by grid or phase control, the power factor decreases almost in proportion to the decrease in voltage. This is brought out by the curve in Figure 18, which shows that the kva input remains almost constant or better than 100 per cent if the output current remains constant, while the voltage, and therefore the output, is being reduced by phase control. Thus, at 10 per cent voltage and full load current, the input kva is 103 per cent, and the power factor is only approximately 10 per cent. This will be further discussed in connection with adjustable voltage systems.

The relative cost of installation between rectifiers and motor generator sets is an extremely important consideration, and it is something that must be analyzed for each particular set of conditions. In particular cases the rectifier equipment may weigh more or less than the motor generator set, but it is static as compared to rotating or dynamic equipment. The rectifier may be set on a simple level floor merely designed for the necessary loading. On the other hand, a special foundation must be designed for the motor generator set, taking into account not only weight, but vibration, torque, proper alignment, foundation settling, entrance and exit of connections and ventilating air, ventilating fans, surface air coolers, and the necessary ducts interconnecting the ventilating system. The intricacies of such foundations and their corresponding costs depend upon many factors, such as size of equipment, space available, details of location which determine the necessary arrangement of equipment, local soil conditions, excavation difficulties, etc.

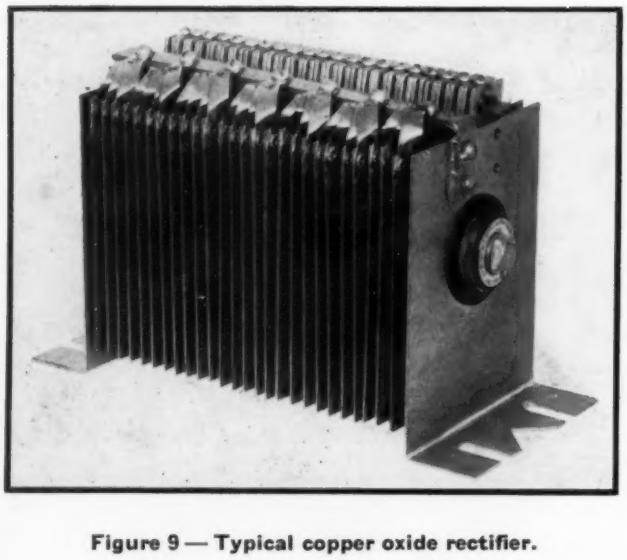
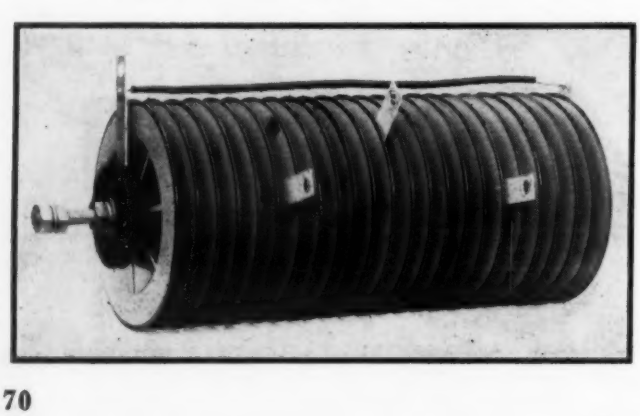


**Figure 9 — Typical copper oxide rectifier.**

▲

**Figure 10 — Typical selenium rectifier.**



Since alignment is not critical and it can be set on a simple floor, the rectifier readily lends itself to a variety of arrangements to suit local conditions. For instance, the transformer may be placed outdoors, and throat connected to the rectifier, or it may be placed in the basement, under the rectifier, etc. Since the rectifier has less losses to be dissipated, and utilizes a very efficient water-to-water heat exchanger, it requires less cooling water. Furthermore, the flow of water is automatically controlled so that full advantage can be taken of incoming water temperature and the higher efficiency at light loads. There are no fans or filters to be contended with for rectifiers, merely an ingoing and outgoing water connection. These factors alone frequently justify the selection of a rectifier.

Another important factor frequently overlooked is that the motor generator set is an appreciable contributor to faults on the a-c system, while the rectifier is not. It is not only important to the reliability and stability of a good a-c distribution system to keep the fault currents to a minimum and yet have a stiff system, but on some systems which are already inadequate from a breaker-interrupting standpoint, the addition of fault-contributing equipment is prohibitive. Furthermore, there is no high starting current such as in the starting of motor generator sets.

The ability of the rectifier to take extremely high instantaneous peaks without appreciable damage should be weighed against the possible flashover damage to a d-c generator.

Maintenance is rather a precarious subject to discuss and, although no attempt will be made here to evaluate relative costs, I think it would be well to bring out certain points which are rather fundamental.

The biggest difference lies in the degree of enclosure and vulnerability to dirt. On the one hand, the transformer has long ago established itself as being most dependable and requiring the least maintenance of any piece of electrical equipment in the steel industry. Why? Mainly because the windings are tightly sealed in an oil filled tank which eliminates the dirt hazard. The use of non-inflammable filling makes the transformer even more attractive, since it is also non-sludging and does not require periodic filtering. Likewise, the commutator of the rectifier, which is, of course, the anode-cathode-ignitor assembly, is sealed in a vacuum-tight tank. Furthermore, material in the cathode and anode is neither removed nor deposited in operation. On the other hand, even though the motor generator set is

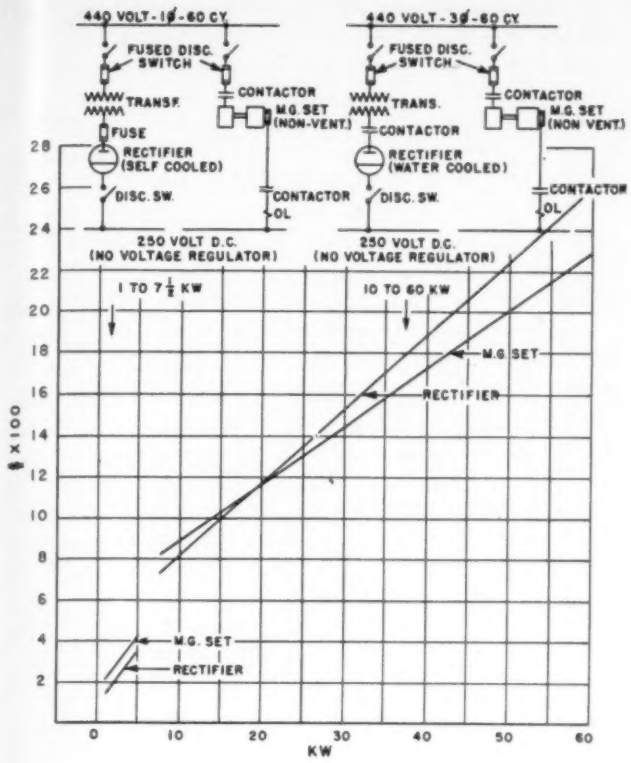



**Figure 11 — Comparison of estimating costs of 250 volt complete motor generator set and rectifier equipments, up to 60 kw.**

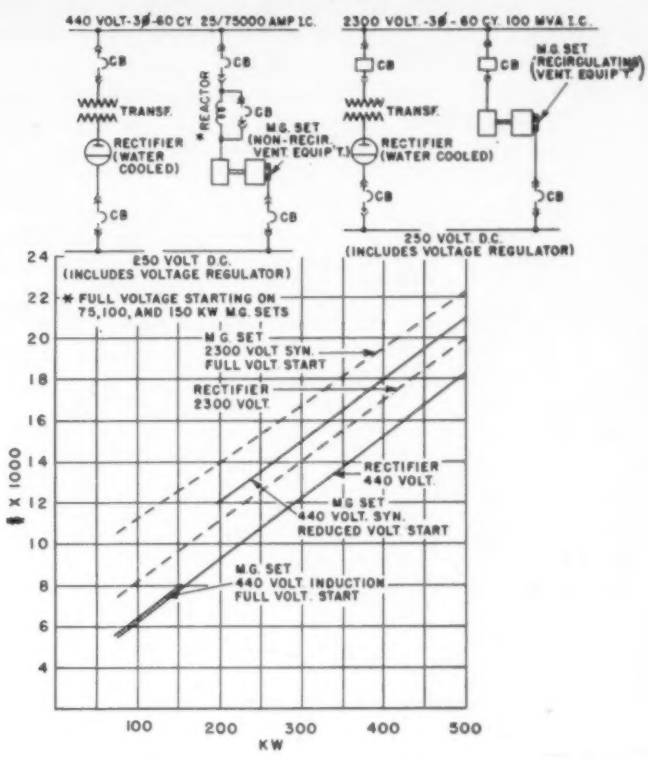
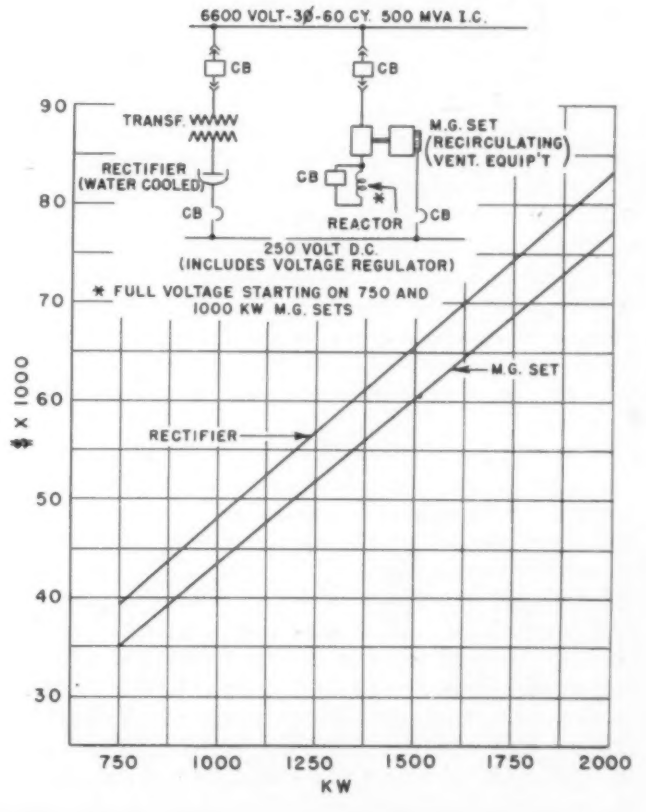

440 VOLT-3Ø-60 CY. 25/75000 AMP I.C.
2300 VOLT-3Ø-60 CY. 100 MVA I.C.
CB
TRANSF.
REACTOR
RECTIFIER (WATER COOLED)
M.G. SET (NON-RECIR. VENT. EQUIP'T.)
M.G. SET (RECIRCULATING VENT. EQUIP'T.)
250 VOLT D.C. (INCLUDES VOLTAGE REGULATOR)
* FULL VOLTAGE STARTING ON 75,100, AND 150 KW M.G. SETS
M.G. SET 2300 VOLT SYN. FULL VOLT START
RECTIFIER 2300 VOLT
RECTIFIER 440 VOLT
M.G. SET 440 VOLT SYN. REDUCED VOLT START
M.G. SET 440 VOLT INDUCTION FULL VOLT. START
$ X 1000
KW

**Figure 12 — Comparison of estimating costs of 250 volt complete motor generator set and rectifier equipments, up to 500 kw.**

▲

**Figure 13 — Comparison of estimated costs of 250 volt complete motor generator set and rectifier equipments, up to 2000 kw.**




totally enclosed with a recirculating ventilation system, the air must be circulated through all the windings, which eventually become clogged with dirt, and are difficult, if not impossible, to clean properly. If a non-recirculating system is used, employing the best filter on the market, the same thing happens. The commutator is not only exposed to dirt in the ventilating air, but to its own wear and that of the brushes.

The next big difference is the comparison of static vs rotating equipment. There is no rotating equipment on the rectifiers except two small pump motors in the case of the pumped units. These, however, are more than offset by the much larger motors which drive the ventilating fans for the motor generator sets. The motor generator sets are not only subject to bearing, brush and commutator wear, but the windings, connections, binding bands, commutators, etc. are continually subjected to dynamic stresses.

The next big difference is in commutation itself. Although the generators used in the steel industry today are probably the finest in the world, we must admit the fact that more trouble is experienced with their commutation than with the d-c motors to which they supply power. Why? For economy reasons they are built to operate at as high a speed as possible consistent with reasonable maintenance and performance. Next, they run almost continuously at their full speed, while the motors are frequently either at standstill or running at reduced speed. This is a very important factor when we remember that brush friction is much greater at light loads than at full loads. Contrasted to this, with the improvements which have been made on rectifiers in

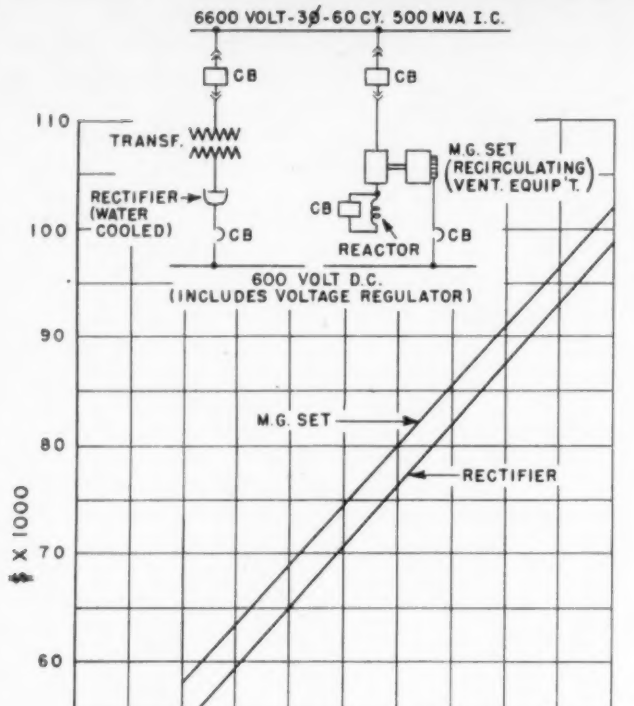



**Figure 14 — Comparison of estimated costs of 600 volt complete motor generator set and rectifier equipments up to 3500 kw.**

the last few years, there are practically no commutation problems or troubles. It is true that on pumped tanks it may be necessary to replace an ignitor occasionally, but their record of life is extremely good. They are relatively inexpensive and readily replaceable. Again, on the sealed ignitrons there is a definite tube or commutating life, and it is necessary to replace them from time to time. These tubes have a three-year warranty and a definite cost which can be evaluated. This maintenance should, of course, be taken into account in any comparison.

When all is said and done, I believe that rectifiers have the fundamentals in their favor from the standpoint of maintenance. Several users have come to their own conclusions that the relative maintenance is half, or less, for the rectifier.

Turning to applications in the steel industry, the vast majority of the 60,000 kilowatts installed have been for general purpose constant potential 250 volt mill supply. This seems sound, and can be justified from an economic and dependability standpoint. In addition, the rectifier lends itself admirably to an unattended substation and, because of its flexibility of installation, can be strategically located at the required load centers. This not only materially reduces transmission copper

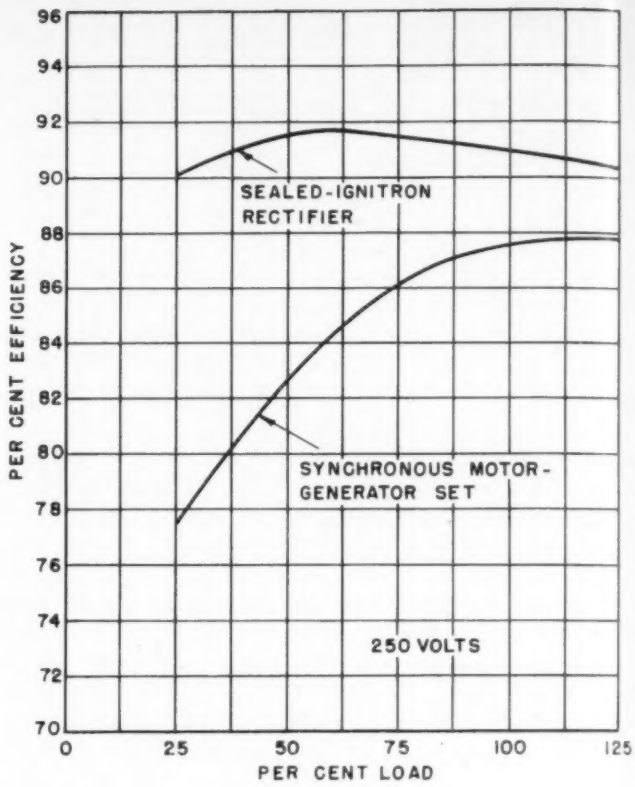



**Figure 15 — Typical efficiency cures of 250 volt sealed ignitron rectifiers and corresponding motor generator sets.**

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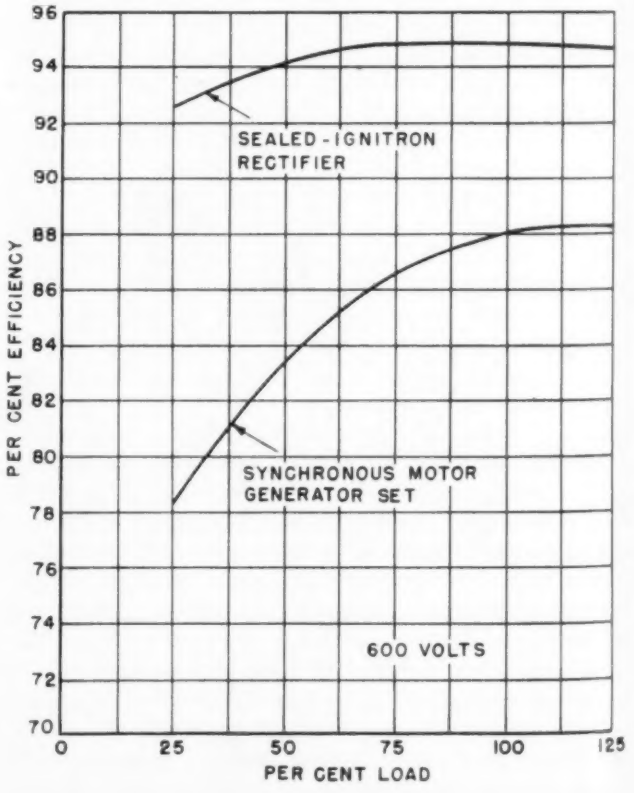
**Figure 16 — Typical efficiency curves of 600 volt sealed ignitron rectifiers and motor generator sets.**



costs, losses and maintenance, but gives much better voltage regulation.

There may even be a logical field for 600 volt rectifiers operating at constant voltage. For instance, it is sometimes desirable to have magnetic starting for the individual drives on small merchant, bar, skelp and rod mills, for which purpose rectifiers would not only be economical but would meet all the operating requirements.

When we come to adjustable voltage applications however, they can be divided into two classes: first, drives which start infrequently and at light loads, and second, drives which start frequently, or under full load torques, or require regenerative braking. In the first group are merchant, bar, skelp, rod and hot strip mills, and in the second, blooming, slabbing and cold strip mills, wire drawing machines, drawbenches, etc. The key to the proper application of rectifiers to these two groups is in grid control and its attendant poor power factor, mentioned previously. Where the poor power factor could in all probability — depending upon the power system — be tolerated for the first group, it could not be tolerated for the second group.

One application belonging to the first group has been made, where a 2500 kw, 600 volt rectifier will be used to start a merchant mill on the West Coast.

The only way of overcoming the objection to poor power factor is to reduce the a-c voltage by tapped transformers, saturable reactors, induction regulators, and the like, all of which are fairly expensive and made the rectifier unattractive from an economic standpoint.

However, a combination of circumstances made one application of this nature attractive. The Weirton Steel Company was going to revamp its hot strip mill, which required an additional 7000 kw at 600 volts to be paralleled with the existing 9000 kw in motor generator sets. Furthermore, a range of only 500 to 600 volts was required. It was found that an economical layout could be obtained by using two 3500 kw rectifiers (Figure 19). The drives are accelerated by voltage control of the generators, and when up to voltage the rectifiers are paralleled with them. For the comparatively narrow range of 500 to 600 volts, the transformers were tapped in several steps and grid control was used to cover the range between taps. Although it was purchased in 1939, war conditions have prevented the installation and starting of this equipment. It is, however, being installed at the present time and will be watched with considerable interest.

There are three ways to overcome regenerative braking problems when using rectifiers: first, by using a separate group of rectifiers, which are prohibitive in cost; second, by using reversing armature contactors, which become uneconomical, as well as a source of terrific maintenance on large drives; and third, by reversing the motor field which is certainly a questionable practice.

All in all, under the present state of the art, it looks as if the use of rectifiers for the second group, adjustable voltage drives, is pretty well limited to small drives. Here there seems to be a legitimate field of application, and hundreds of applications of this nature have been made. The nicety of control which can be obtained with these equipments is their real justification. Figure 20 shows a 1 hp unit of this type. One set of tubes is used for the motor armature circuit and another for the motor field circuit. Since practically no power is required to control the grids of these tubes, inexpensive but highly accurate and dependable high vacuum tubes can be used for the control functions, whether they be speed, current or voltage. Due to the accurate IR compensation which can be obtained, very excellent

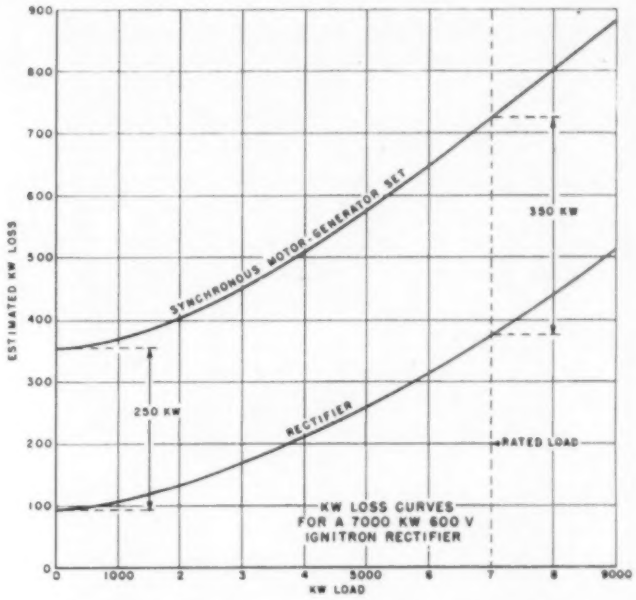



**Figure 17 — Kw loss curves for a 7000 kw, 600 volt ignitron rectifier.**

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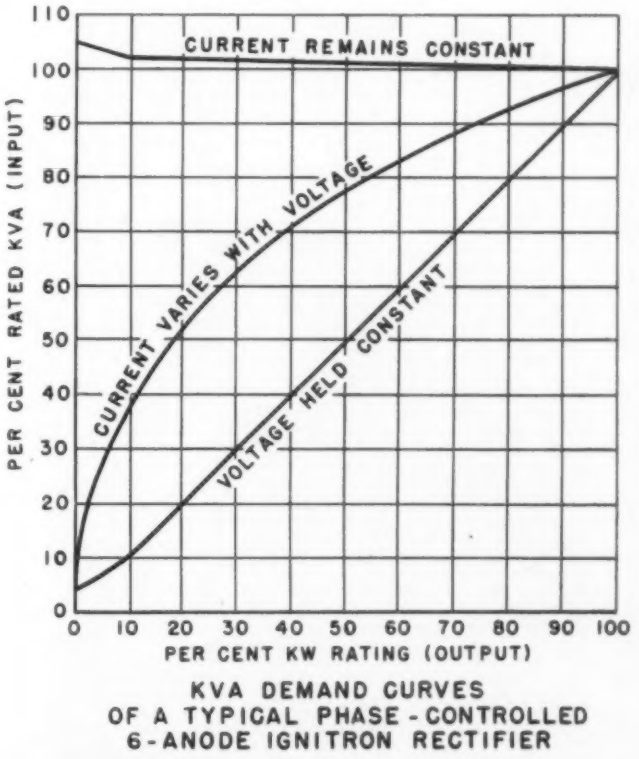
**Figure 18 — Kva demand curves of a typical phase controlled 6-anode ignitron rectifier.**



speed regulation can be obtained over ranges of speed as high as 100 to 1. Units of this type are available in sizes up to 40 hp or even larger. Applications are almost endless.

Before closing, let us go back to the plate type rectifiers. The high maintenance on low voltage, high current motor generator sets has brought these rectifiers into considerable prominence in recent years, especially in

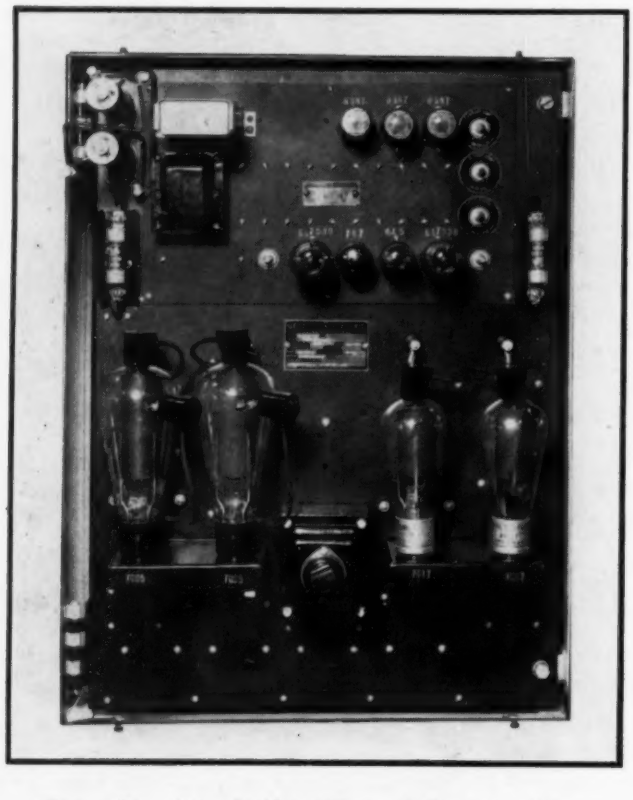


Figure 20 — A typical rectifier unit for 1 hp drive.

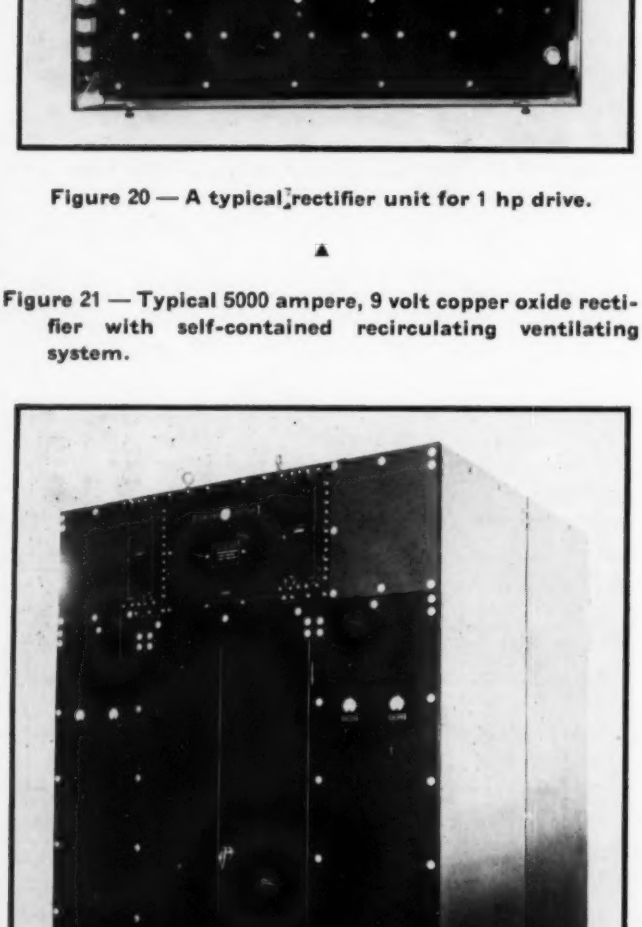


Figure 21 — Typical 5000 ampere, 9 volt copper oxide rectifier with self-contained recirculating ventilating system.

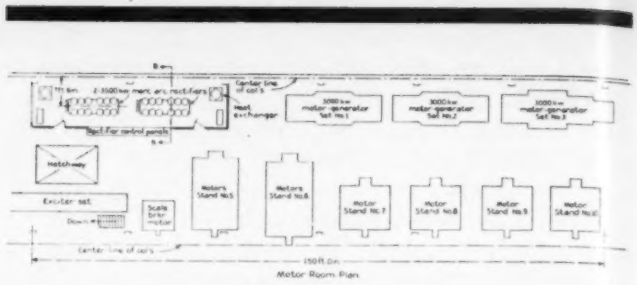


Figure 19 — Layout of a 7000 kw, 600 volt rectifier operated in parallel with motor generator sets for a hot strip mill.

connection with electrolytic tinning lines. The efficiency of the rectifiers is somewhat better, but this seems relatively unimportant.

From the standpoint of cost of equipment, this is about the picture: At 5 volts the rectifiers are somewhat less expensive, at 10 volts about a standoff, and at 15 volts slightly in favor of the motor generator sets. Installation costs are in favor of the rectifier, since no special foundations are required and the rectifiers can be installed in less floor space and with shorter heavy current buses.

Figure 21 shows a typical 5000 ampere, 9 volt unit. The transformers and rectifiers for 2500 amperes are mounted in racks on each side of the entrance door. The heat from these units passes through surface air coolers, which can be seen on each side near the top, and thence through two propeller type fans down into the center compartment, up through the rectifiers, etc. Thus, the unit is self-contained and requires no external ventilation. We have equipped two tinning lines, each having 60,000 amperes at 9 volts, and one line at 75,000 amperes at 10 volts. A total of some 500,000 amperes at an average of 9 volts has been installed on electrolytic tinning lines alone. There has been considerable discussion of copper oxide vs selenium rectifiers. For this service we find so little difference in their performance that we have chosen to stick with copper oxide, mainly because we have had many more years of experience with them. Future operating experience may change our preference, but only time will tell.

In conclusion I would like to express my opinion on the future outlook for rectifiers. I believe that the real field for rectifiers is to supply general purpose constant voltage d-c power and drives which are started infrequently and at light loads. For adjustable voltage drives requiring frequent starting, or under full load torque, or regenerative braking, the application of rectifiers will be pretty much limited to the smaller drives, say 200 hp and under. I believe the plate type rectifier for low voltage, high current is here to stay and will be used more and more in the steel industry. By all means rectifiers should not become a fad, with all of us trying to use them for every type of drive, irrespective of the overall economies and merits of the application. There is, however, one thought we should tuck away in our minds — motor generator sets have been with us a long time and we can not reasonably expect any radical improvements. Rectifiers, on the other hand, are much younger, and we can reasonably expect not only radical improvements but steady growth and development.

# DISCUSSION


PRESENTED BY

H. E. WEISS, Manager, Allis-Chalmers Manufacturing Company, Buffalo, New York

J. T. THWAITES, Section Engineer, Electronics, Canadian Westinghouse Company, Ltd., Hamilton, Canada

R. W. GRAHAM, Superintendent of Electrical Department, Bethlehem Steel Company, Lackawanna, New York

F. MOHLER, Engineer, Steel Mill Section, General Electric Company, Schenectady, New York

C. J. PORTER, Electrical Engineer, The Steel Company of Canada, Ltd., Hamilton, Canada

J. F. BLACK, Assistant Works Manager, Atlas Steels Limited, Welland, Canada


**H. E. Weiss:** Mr. Mohler has given an excellent paper on the rectifier as applied to the steel industry, and I believe that this method of conversion will receive the consideration due it in future expansion and replacement programs in this industry.

For some reason or other, the steel industry in this country was not fully convinced that the rectifier was applicable to their conditions, as was evidenced by the very few installations that were made previous to 1941, although the European steel industry had many rectifiers in service prior to that date.

As far as I know, the first large size mercury arc rectifier installation in the steel industry in this country was at the South Chicago Plant of Republic Steel Corporation. This unit was rated at 1000 kw, 250 volt, d-c, output, was of the so-called multi-anode, single tank type and was operated in parallel with existing motor generator sets for supplying 250 volts general mill services. This unit is still in operation and has given very satisfactory service.

As was previously stated the Republic rectifier is of the multi-anode, single tank type whereas more recent units are of the single anode, multi-tank type. This type has approximately a 3 per cent higher efficiency at 250 volts and about 1 per cent higher efficiency at 600 volts than the single tank units. Furthermore, the newer design is smaller in dimensions for equivalent ratings, much lighter in weight, can be easily serviced and without use of special foundations or overhead cranes. Also, in case of disturbances in the power supply, the stability of this type is better than the single tank type.

Since 1941, our company has installed 24 mercury arc rectifier units in 12 steel plants with a total capacity of 16,400 kw, the units varying in size from 300 kw to 1000 kw, both manually and automatically controlled. A-c power supply is either 25 or 60 cycle, and the d-c output voltage is 250 volts for general mill service. These units operate independently, in parallel with each other, or in parallel with existing rotating equipment.

There should no longer be any doubt in the minds of the electrical personnel in the steel industry that the mercury arc rectifier is a solution to their conversion problems, especially where a constant d-c voltage is required. Present day rectifiers equipped with grid control will maintain a constant voltage at all loads, and also can be made to correspond to the voltage output characteristics, of rotating equipment so that satisfactory parallel operation can be had. For large voltage variations, a combination of tap-changing on primary of transformers and grid control can be used.

The history of mercury power rectifiers in this country dates back to 1924 when the Commonwealth Edison Company of Chicago placed in service two 1000 kw, 600 volt units for railway service. Since that time the application of rectifiers has been extended to many new fields with the result that the present day installed capacity is many times what it was 5 years ago, and no doubt this increase will continue, as research and improvement make this method of conversion more desirable.

**J. T. Thwaites:** The ignitron rectifier which Mr. Mohler mentioned has a much larger record of service than would be indicated by Mr. Mohler's curve where he shows some 60,000 kw installed, as the electro chemical industry has installed well over 2,000,000 kw in the last four years. The enormous blocks of power required by the electro chemical industry have led to some very radical developments, not only in rectifiers, but in their control, and electronic switching of blocks of power up to 60,000 amperes at 700 volts is now being done every day.

The sealed-off ignitron rectifier for small blocks of power has been gradually replacing the small motor generator sets for crane, machine shop and general service d-c, and has particularly had a large field of application in the mining industry, where reliability is of paramount importance.

The use of ignitrons as frequency changers has been proven by the installation at the Braddock plant of Carnegie-Illinois Steel Corporation.

The thyratron rectifiers for smaller power applications are a logical development and it is interesting to note that the Radio City Music Hall uses several hundred such rectifiers for controlling the lighting circuits and that these have given excellent service from the day of their installation.

The plate type rectifiers, both selenium and copper oxides, for high current, low voltage power supply have also a heritage of wide experience, equipments having been in service for a number of years to furnish 27,000 amperes at 12 volts, while a more recent installation to furnish 60,000 amperes at 6 volts is an example of the type and magnitude of these units.

**R. W. Graham:** I would like to ask a few questions in connection with starting of d-c main drive motors from a mercury arc rectifier bus. How much can we expect of the rectifier? How much torque can we get and what are the methods of bringing the mill motors up to speed? I understand there is one plant that is going to start their d-c motors driving the mill stands direct from the rectifier bus.

**F. Mohler:** Drives may be brought up to speed on a rectifier bus in several ways:

1. Operate the rectifier at a constant voltage and accelerate each motor by means of conventional rheostatic control. However, this is only economically feasible for medium-sized drives. Furthermore, this is not a satisfactory method for accelerating drives

in tandem under load. This system might be used on, say, a small merchant mill, but certainly not a large hot strip mill or a cold strip mill.

2. Accelerate the drive or drives by grid control of rectifier voltage. It must be remembered, however, that the power factor under this method of control gets steadily worse as the voltage is decreased. Thus, at 10 per cent voltage, the power factor is 103 per cent lagging. This method is, therefore, only feasible for starting medium-sized drives under full load and large drives under light loads.

3. Accelerate the drive or drives by transformer taps and limited grid control between taps. This materially reduces the bad power factor situation but is complicated and expensive. There is a merchant mill on the West Coast in which it is planned to accelerate the drives by grid control. However, these drives are of moderate size and the mill will be started up "light."

**R. W. Graham:** When you have a flare back, as you say they do, what has to be done to get it back in service?

**F. Mohler:** When you have a "flare back," "kick back," or "arc back," the current goes in the opposite direction to that which the rectifier wants it to go and a short circuit results. This short circuit tends to reduce the vacuum, depending upon its severity, etc. How quickly the rectifier can be put back in service, depends upon how long it takes to re-establish the proper vacuum, which may be from a few seconds to an hour.

At the Michigan Alkali Company we used a rather novel arrangement of anode breakers. These breakers are arranged so that only the anode which arcs back is tripped, rather than tripping all anodes. After five or six seconds, this anode is reclosed and so far as the d-c bus is concerned, it never knows anything has happened. This equipment has been in operation about eight months without a single outage.

**C. J. Porter:** There is one point with respect to rectifiers that has really not been touched either in the paper or in the discussion, and that is the applicability of rectifiers to the service. I am thinking of the application of rectifiers as conversion units supplying d-c power to hot strip mills.

**F. Mohler:** I believe you are thinking about what kind of voltage regulation can be expected on an intermittent load. We would never think of putting in either motor generator sets or rectifiers without regulators. With voltage regulators I would expect even better voltage regulation with a rectifier than with the motor generator set, the secret lying in the fact that it takes less time and less power to regulate the rectifier than the motor generator set.

**C. J. Porter:** That takes into account only the effect of the load carried by your mill. Suppose you had a system from which you are taking power, supplying at the same time a number of electric arc furnaces causing sudden and appreciable voltage fluctuations. What sort of mill speed regulation would you expect if mercury arc rectifiers were used as conversion units? It is true that voltage regulators regulate, but there must be a cause before they will function. We consider it necessary to recognize also that mercury arc rectifiers do not possess any ability to iron out voltage fluctuations and that sudden changes of voltage on the power supply system will be reflected on the d-c bus.

**F. Mohler:** That is a very good point. If you have severe voltage fluctuations on the a-c system, it will be reflected on the d-c bus as fast as it occurs on the a-c system. On the motor generator set you do not get that. You have picked an awfully bad case and under those circumstances, I would select the motor generator set.

**C. J. Porter:** We had to make such a decision and finally chose motor generator sets for the very reason that you pointed out.

**J. F. Black:** Do you know of any European mills that use rectifiers only?

**F. Mohler:** Far greater use of rectifiers has been made in steel mills in Europe than in the United States. They are in use on merchant mills, hot and cold strip mills and even on blooming mills. However, there are many factors involved and I still believe we have taken the proper attitude on rectifiers.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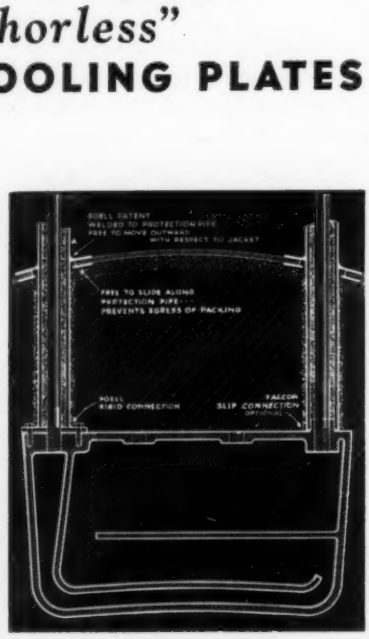


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# Safety Practices

*. . . . setting forth some of the electrical safety practices of Inland Steel Company . . . .*

*by R. L. Beeswy*

ASSISTANT SUPERINTENDENT

ELECTRIC AND POWER DEPARTMENTS

INLAND STEEL COMPANY

EAST CHICAGO, INDIANA

▲ SAFETY for continuity of production as well as for accident prevention has a leading part in the specification, design, operation, and maintenance of all electrical installations.

Daily, through reports, suggestions, observations and investigations of near or actual accidents, new safety problems are presented. All must be disposed of. Some suggestions are impractical, some impossible, others too costly, but many are approved and carried out. There are few standards or rules to govern these safety requests; each must be judged individually.

We agree with Henirich in his book, "Industrial Accident Prevention," when he states: "Although manfailure in its several forms is justifiably indicated as the major cause of industrial accidents, it is nevertheless axiomatic that reasonably safe mechanical and physical environment is a prerequisite and continuing function in accident prevention."

Inland Steel Company, a member of the seven-company exchange, recently submitted a question on how to stop the lowering of a dynamic hoist with an overhauling load should the controller stick or jam. Perhaps the question can be clarified by explaining that the overhauling load, turning the motor as a generator, produces sufficient voltage to keep the contactors closed, even though the main operator's cab switch be opened. Various replies were received. We are now installing control switches in the operator's cages of all cranes. This one switch will open the control circuit to the hoist boards, drop out the contactors and stop the hoist.

Chiefly for the safety feature, individual limit switches for each motor were adopted as standard installation practice for all two-motor dynamic crane hoists following an experience with a ladle crane with a two-motor main hoist, four brakes, and the limit switches of both hoist motors mechanically connected together and tripped from a single weight. This weight became entangled with the hoist cables and was torn loose, tripping the limit switches and opening the dynamic circuits of both motors while the hoist was lowering a ladle of steel. The hoist quickly gained excessive speed. The craneman centered the hoist controller, but the hoist did not stop. The craneman had the presence of mind to trolley out, allowing the ladle to come to rest in a clear spot on the pit floor. The armature of one hoist motor had fanned, the armature coils wedging between the armature and pole pieces and acting as a brake to limit the lowering speed. The craneman was commended on his quick thinking.

As a result of this incident, the limit switches of all dual-motored crane hoists are mechanically separated, each having a separate weight. This prevents the removal of the entire dynamic circuit unless both limit switch tripping weights drop at the same time.

In line with this same incident, a safety practice of periodically checking hoist brakes has been adopted. This is done by lowering a full load with the limit switch manually tripped, allowing the hoist motor to attain

Presented before A. I. S. E. Chicago District Section Meeting, February 6, 1945.

the maximum safe speed, and then signaling the craneman to center the controller, thus applying the brakes with no dynamic circuit. The load should slow up and stop. When the brakes do not slow up the hoist, the limit switch is allowed to reset and reestablish the dynamic circuit to assist the brakes in slowing down and stopping the hoist. The brakes are then properly adjusted. This test assures that the hoist brakes are adjusted to hold in any emergency.

The practice of using red lights as signals or warnings on cranes is avoided and used only as a last resort, due to the possibility of a lamp or circuit failure.

Main switches are located on cranes as follows: a safety switch on the footwalk near the usual boarding point of the crane; another is located in the operator's cage, convenient to the craneman.

Elaborate safety rules have been written and are in force for boarding cranes, working on cranes, and changing overhead lights from the trolleys of cranes.

For the safety value, a crane hoist limit switch failure is treated the same as a motor failure on a crane. Complete replacement limit switches are kept available, and the crane is held down until the limit switch is back in working order again. On cranes with more than one hoist, the hoist with a damaged limit switch may be locked out of service until a more opportune time can be had for its replacement.

Another installation with features worth mentioning is on a soaking pit crane where the crane barrel prevents the craneman from watching the auxilliary hoist block; a four-circuit limit switch is geared to the hoist mechanism so that contacts will close at various heights of the hoist block. Each contact lights a different colored lamp mounted on a marked panel near the craneman, thus serving as a position indicator for the auxilliary hoist. The hoist limit switch is left intact.

For safety as well as operating reasons, wiring prints are examined before installation for interlocking, sneak or by-pass circuits, which may under abnormal conditions produce false operations or prevent some part from functioning. Where possible we request that all electrical interlocks in control circuits be kept the same polarity. This is to eliminate potential short circuits from insulation failures or negligence on the part of workmen. Each new electrical installation, change or revision is thoroughly checked, Units must stop, under any condition, from master switches, stop buttons, emergency buttons, extreme limits, etc.

Another safety installation practice on all drives except cranes is to connect a junior nonfused safety switch in the control circuit, after the fused control switch on the control panel, and mount it under the mill-type master switch. Opening this switch removes all control power from the board and master switch; this switch is opened in an emergency, or while making adjustments or minor repairs to the master switch or machine when there is no danger of a workman being caught in the machine; otherwise, the main circuit must be opened and locked open.

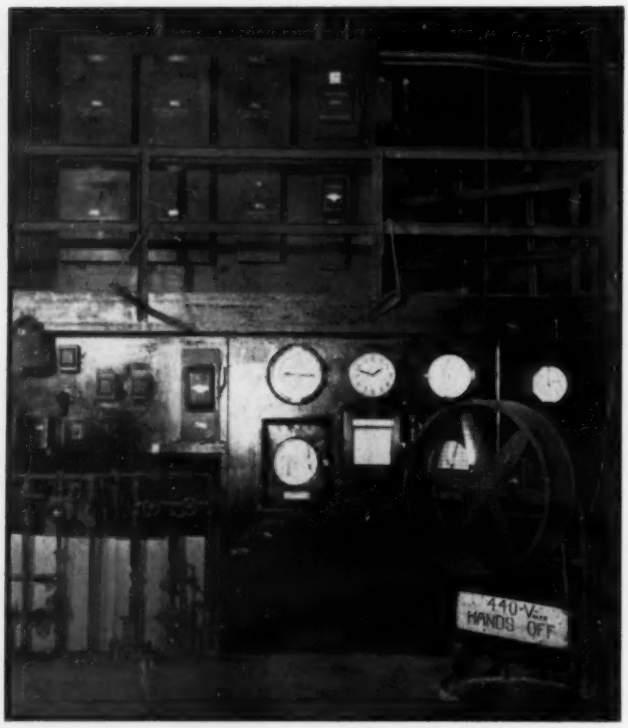
Standardization of master switch locations in mill pulpits, crane cabs, and other units where the drives are similar can be considered as a worthy practice, taking into account the operator's vision, comfort, convenience and fatigue.

While discussing multi-point mill type master switches, many complaints are received that master switches require too much effort to operate, especially where a unit must be spotted. To remedy this we apply vaseline to sliding contacts, and also shape the center and point stops so the switches can be operated with the least effort. Master switches are inspected frequently to see that center stops are not blocked, and are operating. In the investigation of a recent accident it was found that the mill-type master switch of a slab-heating furnace magazine lift had its center stop blocked. As a result, the jar or shock of the load being lowered caused the master switch to move and close the circuit, energizing contactors and resulting in a movement of the drive, thereby catching and injuring the crane hooker's leg.

As a safety feature on units where the continued vigilance of the operator can prevent workmen being caught in machines or burnt from spilled molten metal, spring return master switches or spring return drum controllers and in some instances dead-man switches are installed. This is on units such as scrap balers, pugh ladles, etc.

Safety switches do not always live up to their name, as faults develop which create hazards and even cause switches to be destroyed. At times the operating lever or handle of the switch may be in the open position while the switch blades still make contact with the jaws; or again, the operating lever or handle may be in the closed position while the switch blades are merely touching, and not properly entered into the switch jaws. This usually occurs on the quick make-and-break type switch. Switches have been found where the fibre insulating links connecting the switch blades to the operating mechanism have been broken, allowing a switch blade to remain closed when the switch handle is in the open position. Switch stop and insulation failures have allowed the metal of the switch mechanism to ground or short circuit the switch blades.

**Figure 1 — View of open hearth furnace control panel. One 440 volt safety switch for grouped door motor controllers. Exterior ground lead is twined around power cable to man-cooling fan.**



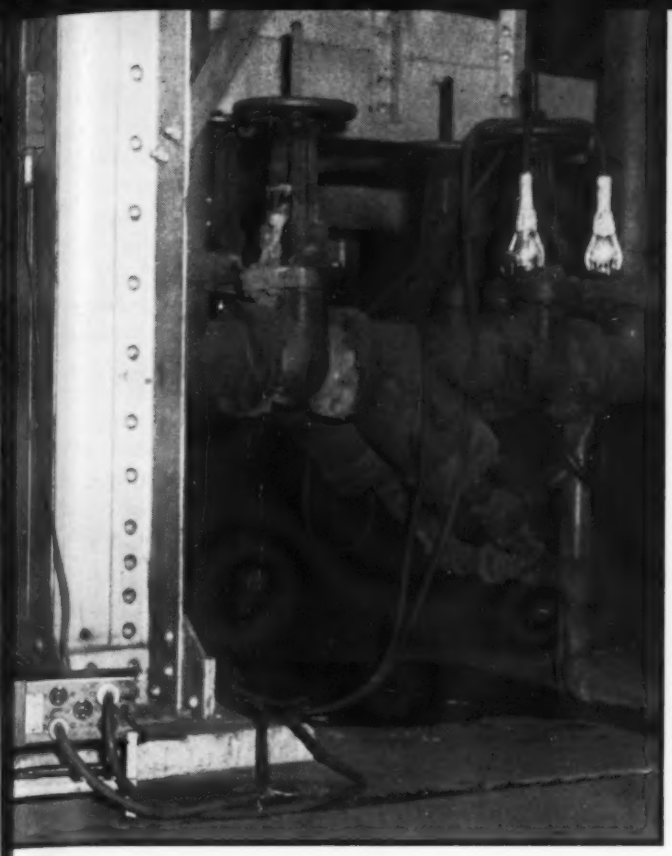


**Figure 2 — Portable 220/12 volt transformer with receptacles for five extension lights.** ↑

**Figure 3 — Main generating station switchboard. Engraved plates above pilot lights give circuit information. "Danger — Do Not Close" tag in use while inspecting one oil circuit breaker of a dual bus system.** →

Safety switches with an inspection window have not been adopted as standard, although there are a few installed throughout the plant. Standard practice is to instruct all concerned personally and at safety meetings, and then insist on switch cabinets being opened and the blades visually checked before attaching a safety lock for protection while working on the circuit or piece of equipment.

Our preference is for a safety switch to have provisions for attaching three safety locks on the operating lever or handle to lock switches open. The adopted standard safety lock in our plant has a 1⅜ in. bail and they are issued to all maintenance men to be kept on their person at all times except when attached to a switch. Attached to the lock is a fibre tag on which is stamped the workman's name, department and check number. This lock must be removed as soon as the job is completed, or when the workman leaves the job.

The adoption of a standard safety lock would be of assistance to switch manufacturers, enabling them to make proper provisions for applying the lock. Safety switches have been received where it was necessary to alter locking features in order to apply our safety lock; the bail length is the usual difference. The long bail (4 in.) was discarded, as when attached to some switches it still allowed closing the switch even though locked open.

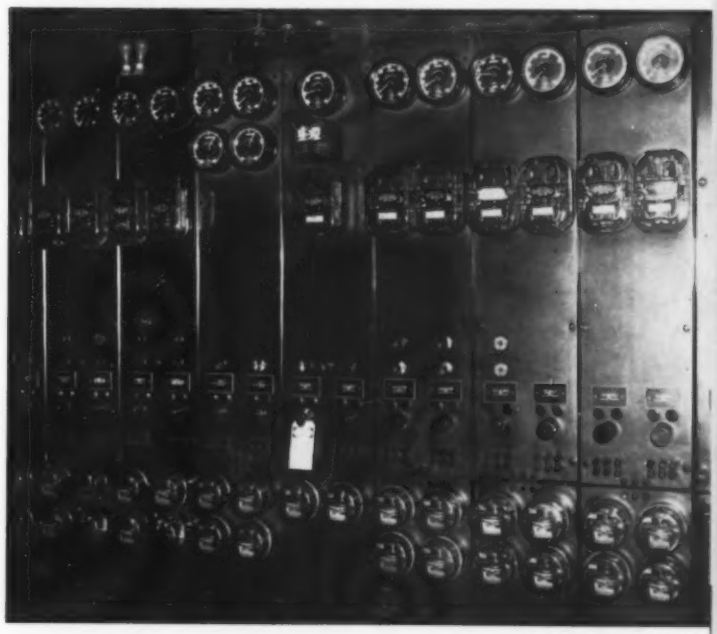
All switches are plainly marked, showing circuit voltage and circuit title. Safety or metal enclosed switches are marked with zinc tags stamped with raised letters and these are securely fastened to the switch enclosure.

Unfused safety switches are installed in the power circuit ahead of motor controller where the motor is protected by a breaker and thermal overload relays. When there are several controllers on a machine or unit which cannot operate unless all motors are running, the controllers may be grouped, and one unfused safety switch of ample size will supply the power.

All 250 volt d-c and 440 volt a-c motor controllers are backed by either a standard open knife switch, one enclosed in a cabinet, or a safety switch. Switches are used for their redeeming feature of indicating visually that a circuit is open.

Safety to the operator has been largely responsible for the adoption of 110 volt control for 440 volt a-c motors.

Except in isolated locations and some offices where the 25 cycle is objectional, 220 volts a-c is used throughout the plant for lighting. Where there are hazards which make the use of 220 volt extension lights objectionable — for example, in boiler drums — we provide 250 voltampere transformers, 220/12 volts, with outlets for five 50 watt extensions. This eliminates the danger of shock and burns to workmen wearing sweaty clothing and working in cramped positions. All extensions have wire lamp guards and wooden safety handles.



Grounded vapor proof fixtures on extension lights are used in the vicinity of inflammable material or liquids, or when explosive gases may be present.

Guns used for spraying benzine thinned varnish are grounded to prevent a static spark igniting the explosive mixture.

Equipment is grounded in accordance with the National Electrical Code. Portable electric tools, man cooling fans, etc. are grounded through a bare conductor, either wire or braid, separate from but spiraled around and tapped to the power conductor cable, allowing the ground lead to be easily inspected. This also prevents splicing the ground lead to a power lead, as has happened where the ground lead was one of a four-conductor cable in a three-phase circuit.

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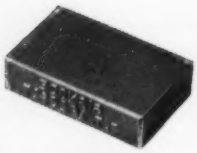
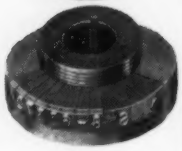


Flat Die for Marking Round Parts

Round Die for Marking Flat Parts



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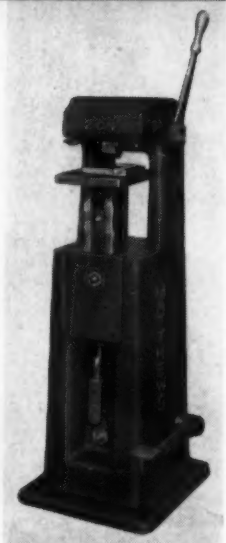

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feeder and tie lines terminating in power generating stations, substations, and motor rooms requires that both the party wanting a line cleared and the station operator check and see that breakers, disconnects or knife switches are open, and a signed "Danger Do Not Close" tag attached. This tag must be removed by the signer before the circuit can be reclosed.

Safety in design of transmission towers requires baskets around all ladders. On high voltage transmission towers, where there are several circuits on each side of the tower, ladders are attached to the extreme outside ends of the crossarms from the tower top to a platform about six feet below the bottom circuit. With this arrangement circuits on one-half of the tower can be cleared for repairs, and linemen need not climb the center of the tower, adjacent to the hot lines on the opposite side.

For protection to pedestrians and other traffic, automatic signal bells are placed at main railroad crossings. Where railroad shipping tracks enter buildings, a convenient pushbutton is provided by which the switchman can blow a siren, warning workmen that a drag of cars is being switched in or out of the building.

Warning sirens, operated by the craneman, are provided on some cranes where the surrounding noises conflict with the sound of the standard foot-operated gong.

In our plant a main roadway passes through a storage building containing a magnet-handling overhead crane. An automatic signal system is being installed to warn automobile and truck traffic when the crane is carrying a lift over this roadway. The control will be actuated from a third rail on the crane and runway to operate standard highway traffic lights that will flash on and off.

A safety practice on which too much importance cannot be placed is the correct arrangement of crane trolley collector shoes for a dynamic lowering hoist, where the motor armature, the series fields, and the series brake are permanently connected in series, except with the hoist limit switch in the tripped position. The trolley shoe leads are usually known as armature, armature and field, field and brake, and brake. The armature lead and the brake lead should not be connected to adjacent trolley shoes, for if these two leads make contact by the shoe of the one above dropping on the one below while the crane is carrying an overhauling load, the hoist, once started and with series brake released, will drop the load to the floor. The explanation is that by the armature and the brake leads coming in contact, a local circuit is completed, and the overhauling load generates sufficient current in the motor to keep the series brake released. Inland's standard trolley shoe arrangement places the armature shoe at the top, armature and field shoe second, field and brake shoe next, and brake shoe at the bottom.

Safety meetings are held on an average of twice a month, arranged so men on all shifts can attend. Each one in attendance is asked what he has to report for safety. Much stress is put on having unsafe acts or conditions reported immediately. All practical suggestions are given item numbers and carried on future reports until disposed of. Letters dealing with safety and new rules are read and explained. The meeting is concluded by a conference discussion of a topic previously selected. These topics cover all known hazards in the department.

# *Pit Furnaces* AT LUKENS

***. . . . of special design, these pit furnaces heat a wide range of slab ingot sizes with excellent results, using natural gas or fuel oil with equal facility . . . .***

*by H. S. Hall,* FUEL ENGINEER
LUKENS STEEL COMPANY
COATESVILLE, PENNSYLVANIA

▲ WHEN it became necessary some years ago to increase the heating capacity for the world's largest plate mill, the 206 in. mill at Lukens Steel Company, two facts had to be kept in mind. This increased capacity was to be used, first, to heat ingots or slabs weighing from 50,000 lb to 115,000 lb each; secondly, at some time in the future, the normal sizes of the ingots to be heated in these pits would be much smaller, with of course an occasional heat of the larger sizes.

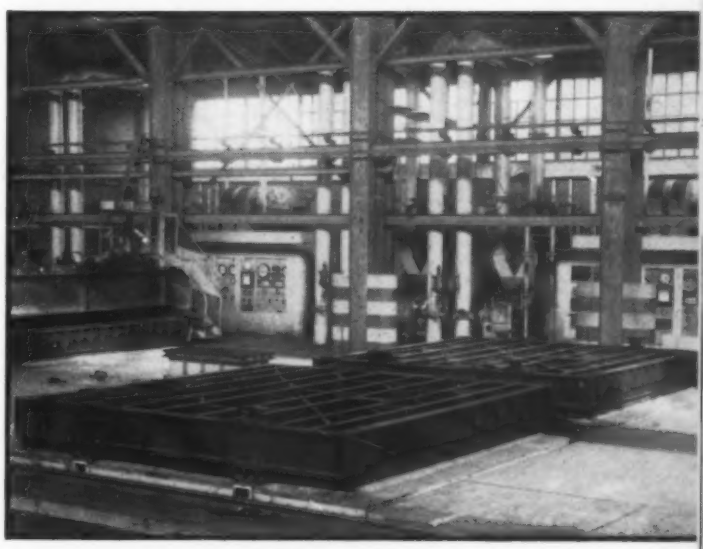
With these conditions in mind, the field of existing pits was looked over to find one that would meet these requirements. The ingots or slabs varied in size from 90 in. x 40 in. x 120 in. for the largest to 80 in. x 30 in. x 86 in. for the 50,000 lb ingots. When two 115,000 lb ingots are set in a pit, there is not much choice as to their position, unless of course, the pit is very large. There was not too much room available for these new pits, so it was necessary to conserve as much as possible on space.

No pits were found that were deemed capable of giving the desired heating of these large ingots.

Some years previous, there were installed four holes of pits which were used for heating 90 in. x 40 in. ingots for this mill. These pits gave uniform heating but at a rather high fuel consumption. It was felt, however, that with proper control equipment and a suitable recuperator, a soaking pit built along the same lines would give the heating desired, as well as a better fuel economy

Eight holes of this general design, but with new recuperators and full control, were built for the 206 in. mill. These pits were put in operation in January, 1941. Four of these holes are 10 ft 6 in. x 11 ft 9 in. x 15 ft 9 in.

**Figure 1 — New pits installed in connection with 120 in. plate mill. Panel boards in background carry equipment for complete automatic control. Cover-crane is shown at extreme left.**



Presented before A. I. S. E. Philadelphia District Section Meeting, February 3, 1945.

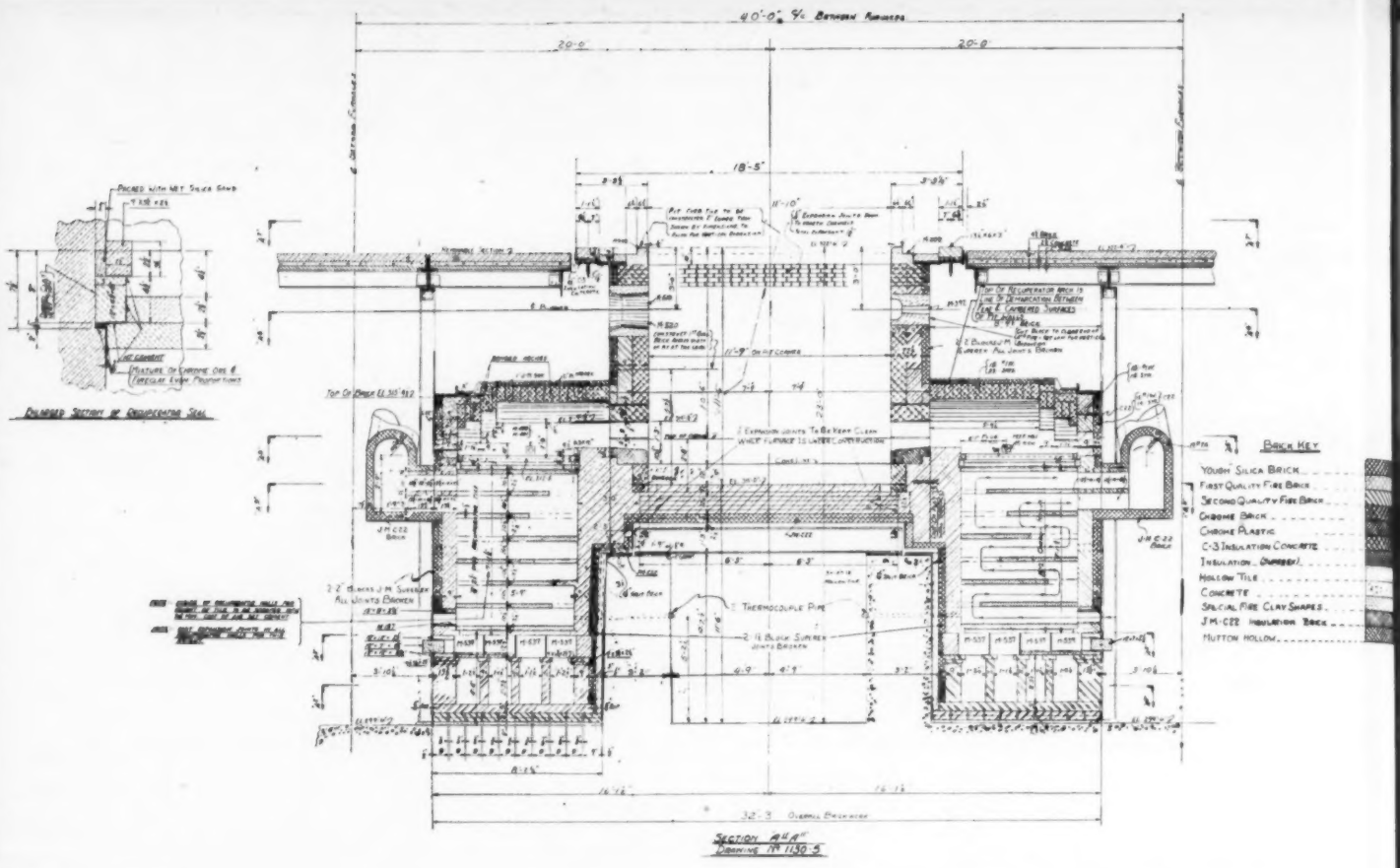
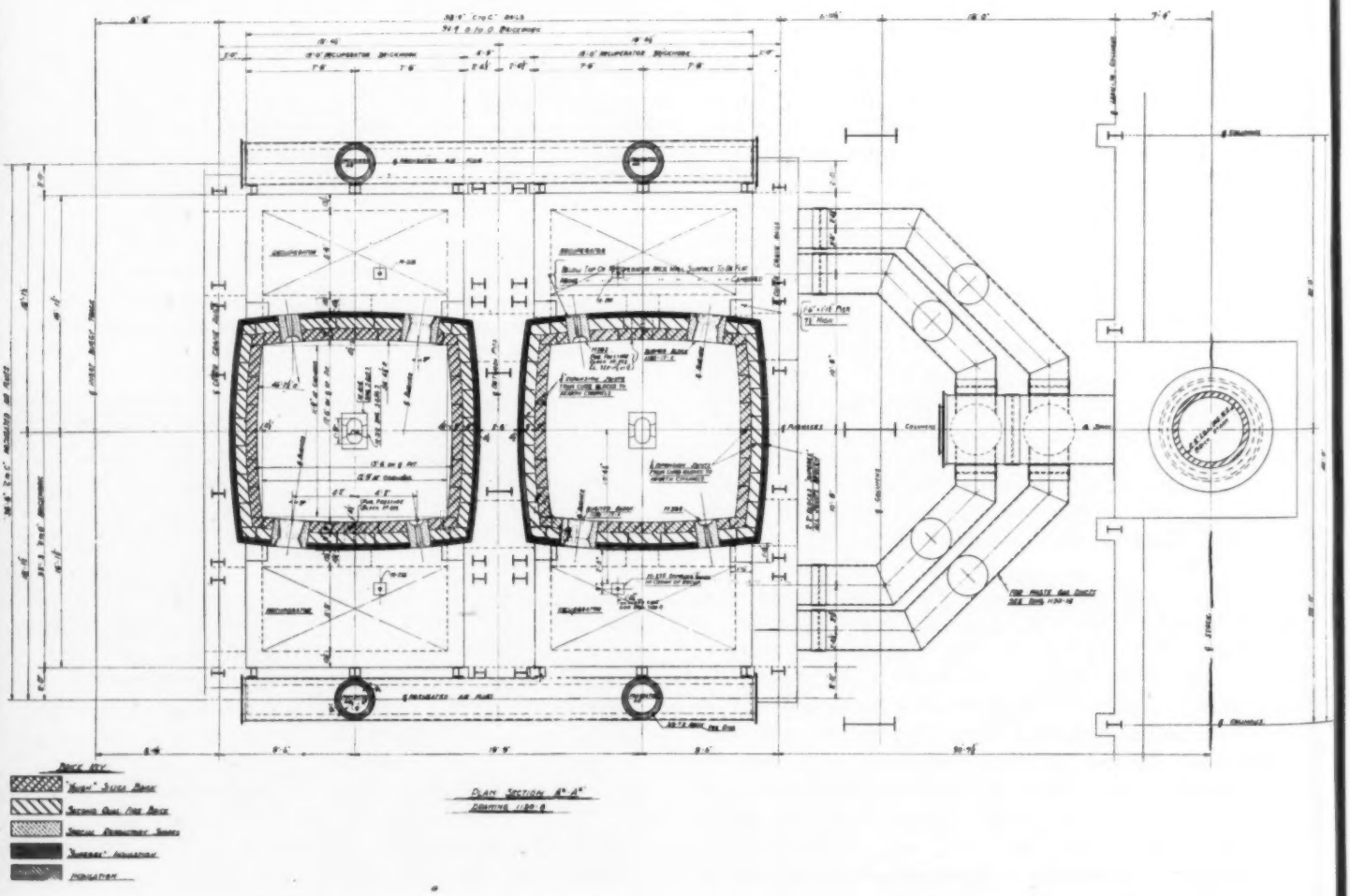



**Figure 2 — Cross-section of recuperative pits through waste gas ports.**

**Figure 3 — Plan section of pits at burner blocks.**



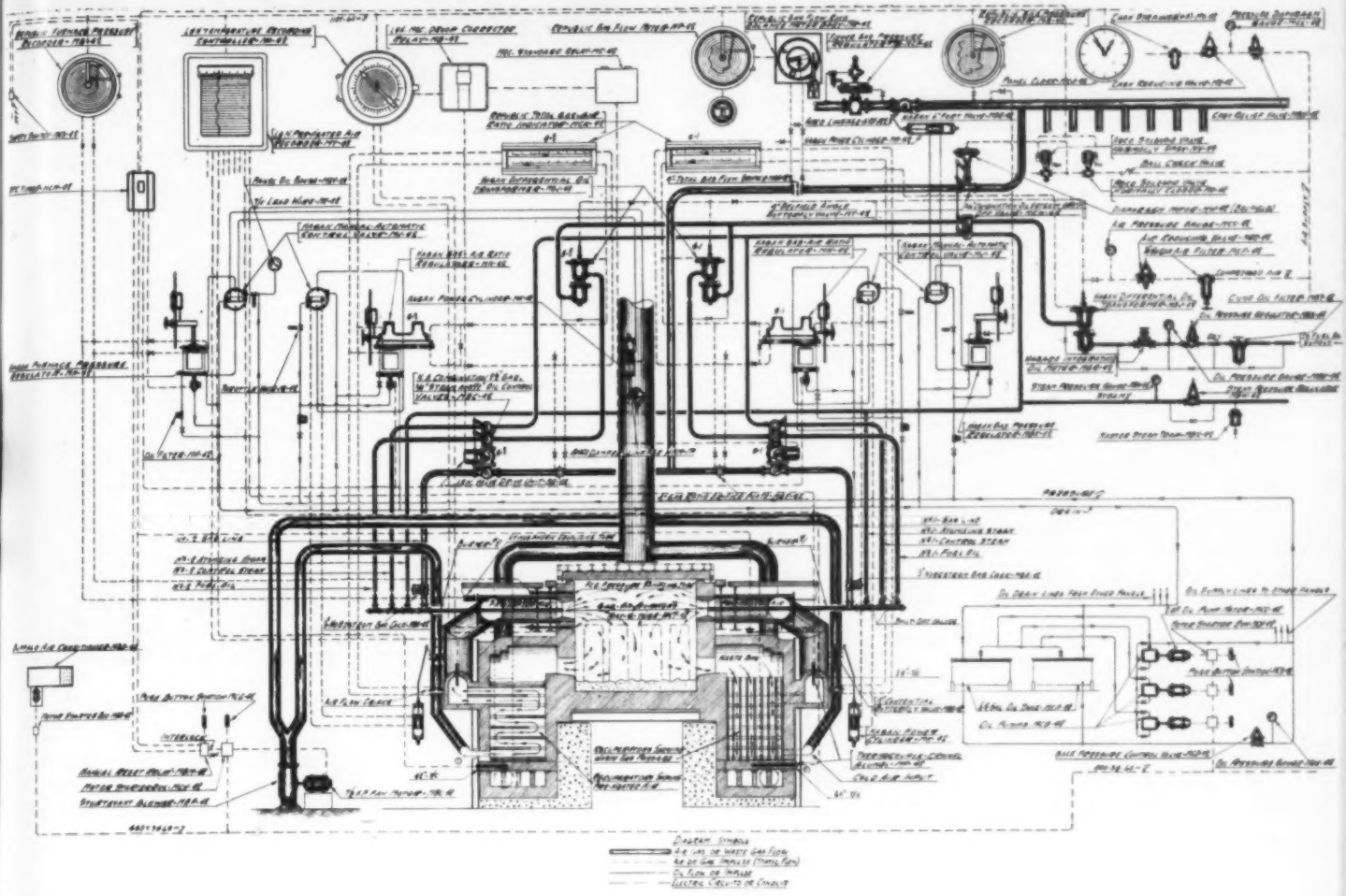


**Figure 4 — Diagram of automatic controls for recuperative pit.**

deep. The other four holes are 10 ft 6 in. x 11 ft 9 in. x 12 ft 0 in. All the pits are actually of the same depth, but the four shallow holes are filled with brickwork in the form of a false bottom to give the 12 ft depth.

The 15 ft 9 in. pits are used for heating the large 90 in. x 40 in. x 120 in. slabs and ingots, and the four shallow holes are used for ingots of 50,000 lb and less. These original eight holes of pits in the 206 in. mill were fired with natural gas. No provisions were made for any auxiliary fuel.

Experience with these pits in the 206 in. mill had been so satisfactory that it was decided to install the same type of pit in the new 120 in. mill. The size of the new pits varies slightly from those installed in the 206 in. mill, measuring 12 ft 7 in. x 13 ft 7 in. x 11 ft 6 in.

The 206 in. mill pits had been operated with cinder bottom, and up to this time it had been necessary to dig bottom only once in these pits.

It was known that the size ingots to be charged would be much smaller in the 120 in. mill, but it was felt that this would help rather than hinder the heating of steel. Slabs from 8 in. x 32 in. to ingots 17 in. x 53 in. are heated in these pits. All ingots or slabs are placed so the long face of the ingot is perpendicular to the wall in which the burner is located. The charge is twenty-four 32 in. x 8 in. slabs per hole or sixteen 53 in. x 17 in. ingots. The number of intermediate size ingots varies between these two figures. The total weight per hole is always close to 100,000 lb. The average overall heating time, charge to charge, is nine hours.

After the pits were installed, it was decided to try cinder bottom in the 120 in. mill. To date, these pits have operated slightly more than one year and we have dug bottom three times. It is felt that the reason it has been necessary to dig bottom more often than on the 206 in. mill pits is the greater number of pieces handled in the 120 in. mill.

The original pits in the 206 in. mill were built for natural gas firing only. However, due to shortage of natural gas and to insure continuity of operation, it was decided to install equipment in the 120 in. mill pits to enable either natural gas or bunker C oil to be used as fuel.

Natural gas is supplied to both the 120 in. mill and the 206 in. mill pits at 30 in. water pressure from a line pressure of 42 psi through two stages of pressure reduction. The first stage is from 42 psi to 5 psi through a pressure reducing valve. The second stage from 5 psi to 30 in. water column is through another reducing valve. The oil is furnished to the 120 in. mill pits at a line pressure of 150 psi and a temperature of 210 F. There is a circulating oil system with one steam oil heater thermostatically controlled for all the pits and furnaces in the mill. .

Oil is kept in constant circulation, summer and winter, by means of a small motor-driven pump. The oil pressure is reduced in two stages from 150 psi to 60 psi, and from 60 psi to 25 psi ahead of the oil control valve. It was found necessary to use two stages of reduction rather than one stage due to the inability of one valve to hold a constant pressure.

Atomizing steam is available at 125 psi and 50 degrees superheat, and is reduced to 40 psi ahead of the control valve. There is a separate steam line to an inspirator on each burner for keeping the burner cool. This steam is available at the burner at line pressure.

Figures 2 and 3 show the general layout of the soaking pit. These pits are top-fired with two burners in diametrically opposite corners of the pits with flue openings near the bottom of the walls in which the burners are located. These flues open directly into the tops of two separate recuperators, one on either side of the pit. Each recuperator cell supplies preheated air to the burner directly above it. The flues from these recuperators join to form a common flue to the stack. There is a hand-operated damper in each individual recuperator flue which may be used for balancing out the system.

Figure 4 shows a schematic diagram of the controls on these pits. These pits are fully controlled, having temperature control, fuel-air ratio control, and furnace pressure control. Each burner has an individual fuel-air ratio controller. It was found that this gives much better control than a single fuel-air ratio control in the main gas and air lines. There are flow indicators on each of the gas and air lines to the individual burners, which give an immediate check on pit operation. Each pit has a round chart potentiometer controller operating from a radiation pyrometer for controlling pit temperature. Each pit has a recording and integrating meter which records and totalizes the flow of natural gas or oil, depending upon which fuel is being used. Each pit has a furnace pressure recorder. There is an eight-point recording potentiometer mounted in the center of the control panels for each row of pits. This records the preheated air temperature to each burner and the flue gas temperature from each recuperator cell.

Each pit is equipped with automatic fuel shut-off which shuts off the fuel when the cover is lifted and turns it back on when the cover is replaced. There is also a three-way manually operated switch by which the fuel can be turned on or off regardless of the position of the cover. This is a help in lighting up.

The connection for the furnace pressure controls and furnace pressure recorder is about 36 in. below the cover in the center of either wall in which a burner is located. There is a small inspection hole in the center of each cover, and the furnace pressure is held at such a point that there is just a slight flicker of flame out this hole. This gives a reading of .02 to .03 in. of water on the furnace pressure recorder. With this furnace pressure, the fuel flow will modulate down to between 1000 and 2000 cu ft of gas per hr. The radiation pyrometer for each pit is located directly opposite one burner, but is not directly in line with the flame from the burner, since the burners are set on a right angle to a tangent with the curve of the side walls of the pit. For normal operation, that is with no holding hot time, the drawing temperature is between 2350 and 2400 F, as shown by the potentiometer controller.

**Figure 5 — Two of these 110,000 lb ingots comprise a charge for one pit. They are charged cold and brought up to rolling temperature in 24 hr.**

Preheated air temperatures average 1200 F at the burner. Flue gas temperatures at the outlet of the recuperator average 800 F.

The burner blocks are 15 in. in diameter at the throat and 18 in. in diameter at the face. The total length of the block is 18 in. Some of the blocks are tile and some are plastic. The plastic blocks have given much better service than the tile.

The gas burner pipe is 25 per cent chrome, and is 4 in. inside diameter. The oil burners are ½ in. extra heavy, pipe with a ¼ in. nozzle on the tip. The oil mixers are of standard make. The ½ in. burner pipe is inside of a 1¼ in. pipe through which a mixture of steam and air is blown from the inspirators at all times for cooling purposes. The oil burner is centered in the 1¼ in. pipe by three spacers along its length.

Flame action or travel in these pits is more or less of a circular motion down through the ingots until it is exhausted at either side at the bottom. It was thought at first that the travel would be in more or less well defined lines, that is from a burner to a definite part of the port opening. This has not proved to be the case as far as can be determined. If there was a definite course of travel of the flame, localized hot or cold spots would be experienced. This is not the case. The only time cold butts are experienced is when two or more ingots are placed too close together. An ingot that is too long will stick up into the flame and of course will be washed, which of course cannot be blamed on the pit.

The heating cycles on plain carbon steel are the same as is common to the steel industry. On alloy steels, the

practice is the usual slow heating to a certain point, soaking at this temperature, then the period of bringing the steel up to rolling temperature and soaking at this point. On some types of steel, especially large ingots and slabs weighing upwards of 80,000 lb, it is necessary to open the pits and cool them down to black before the steel is charged. The covers are then closed and the steel and pits equalized for a period of three to four hours. After that, the fuel is put on and the steel brought up to rolling temperature and soaked.

Two 110,000 lb ingots are heated per pit in this manner with a total elapsed time of twenty hours. It should be noted that all steel charged in the pits in either the 206 in. mill or the 120 in. mill is cold, having been sent to the steel yards for conditioning prior to charging in the pits.

On the 206 in. mill pits, a maximum fuel input of 12,000 cu ft of natural gas per hr is used. On the 120 in. mill pits, a maximum fuel input of 15,000 cu ft of natural gas per hr or 125 gal of fuel oil per hr is used.

The fuel air ratio controllers are set so that the flue gas, as it leaves the pit, is as close to 0.0 per cent oxygen and 0.0 per cent CO as possible.

Since the 120 in. mill soaking pits have been in operation, there have been two periods of operation on natural gas and two periods of operation on oil. These pits function as well on one fuel as on the other. There is no apparent difference as far as quality of heating is concerned between natural gas and oil, and the tons per hour and Btu per ton are practically the same.

# DISCUSSION

**PRESENTED BY**


**A. J. FISHER, Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland**

**L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland**

**F. C. SCHOEN, Plant Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania**

**M. A. FAY, Ceramics Engineer, Bethlehem Steel Company, Sparrows Point, Maryland**

**C. E. DUFFY, Assistant Fuel Engineer, Bethlehem Steel Company, Sparrows Point, Maryland**

**F. H. SPIESS, Fuel Engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania**

**W. C. SCHULZ, Superintendent Power and Maintenance, Bethlehem Steel Company, Steelton, Pennsylvania**

**H. S. HALL, Fuel Engineer, Lukens Steel Company, Coatesville, Pennsylvania**


**A. J. Fisher:** I know Mr. Hall has had a great deal of success with the Lukens pit and has played a large part in its development.

I have three questions. What difficulties have been experienced with the recuperator in respect to leakage, etc., and what air temperatures are achieved?

The second question is, how is the fuel oil measured for control purposes? In other words, how is the impulse taken from the oil line?

The third question has to do with slagging of the pits. At Sparrows Point we have soaking pits heating some 350,000 tons of steel a month which are bedded down in coke breeze, more or less according to the usual practice. We use 2000 tons of breeze a month — a practice we would like to eliminate. I would like to have Mr. Hall discuss just what goes on in his pit that makes the bedding with coke breeze unnecessary.

**L. F. Coffin:** I would like to know whether the temperature control is entirely automatic or whether the automatic feature is applied only to certain parts of the cycle. The fact that you have to cool the pit down between each heat must impose a severe burden on the refractories and it would be interesting to know the types of refractories used in the walls, and also the types of refractories used in the plastic burners.

The use of fuel oil is interesting in such relatively close quarters, and it might be interesting to know whether uniform heating is obtained.

**F. C. Schoen:** We have no furnaces of the pit type in our plant, but we do charge cold metal in other types of furnaces. This similar condition of charging brings up one question. How many gallons of oil are required to heat a ton of cold steel to forging or rolling temperature in the pit furnaces discussed? The answer to this would enable a comparison to be made between a modern pit furnace and older type carbottom and batch furnaces.

**M. A. Fay:** What refractories are used in the lower sections of the side walls of the pit? In these sections of the pit walls we experience more difficulty with refractories than we do in other sections of the pit. We do have fairly good life in these sections using basic brick, but we feel that this life is obtained in part by the use of a coke breeze bed.

**C. E. Duffy:** We want to take the furnace temperature of our pits at Sparrows Point. However these pits are so constructed that it is practically impossible to take temperatures through the side walls. About two years ago, we tried taking temperatures through the pit cover, but the results were not too satisfactory.

Have you had any experience on taking pit temperatures through the cover?

**F. H. Spiess:** We have soaking pits at our plant similar to those at Lukens, although the method of firing is somewhat different, in that we fire either oil or coke-gas up through a circular port located in the bottom of the pit. We have not had any particular difficulty with our pits. As a matter of fact, they have operated exceptionally well over a continuous four-year period.

However, since Lukens operates with a cinder bottom, I would be interested in knowing if recuperator inspections have disclosed any slagging conditions — particularly on the top section.

**W. C. Schulz:** The covers of the pits described seem to be pretty tight. I would like to have a little detail as to the method of sealing and handling. Apparently the only opening was a little peep hole at the top.

**H. S. Hall:** The recuperators are of tile construction with silicon-carbide tubes in the first pass only, at the point at which the cold air enters. Silicon-carbide tubes will withstand the initial thermal shock of the cold air on hot tubes. We do have some leakage, perhaps in the neighborhood of 5 per cent. Our fuel-air ratio controllers are set by taking readings across the gas orifices and the air orifices with water gauges, to give theoretical fuel-air ratio. We then check the flue gas at the outlet of the pit through a hole in the top of the recuperator arch. We take samples at that point on either side of the pit and set the ratio controllers up to give as close to zero $0_2$ and CO as it is possible to obtain. Usually the control dial is set at about 105 per cent which gives 5 per cent excess to take care of the leakage.

For oil measurement we use differential transformers, in which oil flow is changed to differential pressure and that pressure is transmitted to the high pressure side of the gas diaphragm on the fuel-air ratio controller. We check these differentials when the pits go on oil operation and periodically thereafter and find they hold very well.

I do not know what else to say in regard to slagging of the pits except that we do not have it. As stated, the 206 in. mill pits were dug out once in three years' time and they operated practically every day. We get a scale jacket that is tight and yet not too tight. The biggest complaint we have had on the 120 in. mill pits is that the jacket falls off when it hits the mill tables. In other words, why can't it drop either before or after it gets on the table? Naturally, we do knock some of the jackets off in the pits in handling. That is what gives us the cinder we get on the pit bottom. The 120 in. mill was down for general repair sometime ago, and we dug all the pits a third time. It was not really necessary to dig them at this time. We had in the neighborhood of about 7 or 8 inches of cinder in spots. We can normally run 12 to 13 inches of cinder before it gets to the port openings.

The temperature control is completely automatic. The heater sets the pointer or "front-setter" on the potentiometer controller at the desired pit temperature. We try to insist that they leave the pointer set at the temperature at which they wish to draw the pit. What we are trying to break them of is looking at the steel in the pits. We want them to leave the cover down and depend on the instruments. If they know the instruments, they can tell whether anything is radically wrong or not. We have them to the point now that they do not open the pits until the gas or oil starts to cut back. That is normally a period of 1½ to 2 hours, depending on how cold the pit was, and so on. But after that, we try to hold them to taking a look once an hour, because every time they open the pit, we lose a little temperature. If they would wait until the gas or oil flow modulates down to a straight line it would be much better. We have proved to them that when the oil or gas flow comes out in a straight line they can draw the pit.

Silica brick is used for sidewalls. Ordinary first grade fireclay brick is used for the bottom itself. Along the cinder line of the sidewalls we use nothing but chrome brick.

In the flue outlets we originally had silica firestone. The flues, by the way, vary in width. They are about 20 in. high and anywhere from about 10 to 16 in. wide, getting wider near the end of the wall, but the firestone did not stand up and we substituted chrome brick and find that it stands up very well.

As to the uniformity of heat on fuel oil, we get a very uniform heat. If you stand at the mill and watch the ingots come down, you cannot tell which ingot was drawn from what part of the pit. On larger ingots, if they could spin them, you couldn't tell top from bottom. We wash very few ingots except the ones that are too long and stick up in the flame, when the top may be washed a trifle.

Mr. Schoen asked about gallons of oil per ton of steel. We have it in Btu per ton. We figure 150,000 Btu to a gallon of oil and 1150 Btu per cu ft of natural gas. Last year we averaged for the entire eight holes of pits, including all the oil and gas burned for lighting up and shutting down, etc., 1,500,000 Btu per ton. That was starting the mills up and all the mistakes included. We keep a weekly fuel figure which includes light-up and we have been around 1,450,000 or so, but 1,500,000 seems to be normal operation. On the 206 in. mill pits we get below that. We get down to 1,200,000-1,250,000 Btu per ton.

We have never tried taking pit temperatures through the cover. Our temperature is taken through the side wall of the pit, and I want to point out that it is nothing but relative temperature. We do not say that it is steel temperature at all. We say when the pit gets up to 2350 F we know it is the temperature that is required in the pit to give proper steel temperature for rolling. The steel temperature is somewhere near that.

We have been in all our recuperators and have not found any slagging condition. Our 206 in. mill pits went through a flood two years ago. They were hot when the water came up. The water came up in a matter of an hour or so, and flooded in on the hot pits and naturally cracked some of the tile. The recuperators were inspected and the cracked tile replaced. We have had no further trouble.

Covers are handled with a cover crane which moves along the pits from one row to another. Either one or both covers of a row may be raised as desired.

The covers seal in sand. There are alloy castings the entire perimeter of the cover. These castings are approximately 4 in. long and we keep better than that much depth of sand in the seals. This sand is rather coarse and it does not slag or sinter. The cover rests on supports of its own. This arrangement gives a very tight cover, one which can be handled easily and is free from mechanical difficulties. The only opening is a small peep hole in the center of the cover.

A. S. GLOSSBRENNER
CLEVELAND DISTRICT

C. E. S. EDDIE
DETROIT DISTRICT

A. MONTGOMERY
PITTSBURGH DISTRICT

# NEW DISTRICT CHAIRMEN, A. I. S. E.

Albert S. Glossbrenner attended the University of Wisconsin and later entered the employ of the old Illinois Steel Company, one of the predecessors of Carnegie-Illinois Steel Corporation, at the Gary, Indiana tin plate plant. He then transferred to the same company's South Works at Chicago as assistant foreman. Five years later he joined Youngstown Sheet and Tube Company at Youngstown, Ohio, as assistant superintendent of the hot strip mill, becoming superintendent about three years later. He was appointed superintendent of the Brier Hill plant in September, 1942, and in 1943 was named general superintendent of the Youngstown district of The Youngstown Sheet and Tube Company.

C. E. S. Eddie was born in Oban, Scotland, in 1905, graduating from Whitehill Higher Grade School, Glasgow, in 1921, and from Royal Technical College Glasgow in 1927. He started with the English Electric Company as an estimator and then served a regulation engineering apprenticeship with the Steel Company of Scotland, Blochairn Works, Glasgow.

He came to America and was employed as a draftsman by the Pennsylvania Salt Company in Wyandotte, Michigan, was advanced to the position of power plant engineer, and later became master mechanic in charge of all electrical and mechanical equipment. In 1938, he was employed by Great Lakes Steel Corporation, Ecorse, Michigan, in the engineering department and was later transferred to the steam and fuel department, where he became plant lubrication engineer, and in 1944, was promoted to his present position of assistant superintendent of the steam and fuel department.

Alex Montgomery, Jr., was graduated from University of Kentucky in 1928 and was employed by The American Bridge Company as a structural engineer at their Ambridge, Pennsylvania, plant. In 1934 he was transferred to the operating department in industrial engineering work. In 1935 he transferred to the American Sheet and Tin Plate Company, serving as plant industrial engineer from 1935 to 1937. Moving to Duquesne Works of Carnegie-Illinois Steel Corporation in 1937, he served successively as plant industrial engineer, superintendent of bar mills, superintendent of rolling, and in 1944 was made assistant general superintendent.

J. S. Lother was born in Atlanta, Georgia, and received his early education in Birmingham, Alabama. He entered the employ of Tenneseşe Coal, Iron and Rail Road Company, working in various capacities in the blast furnace and open hearth departments, and in the executive office, and was subsequently transferred to his present position of electrical buyer in the purchasing department.

Aaron D. Howry was born in Lancaster County, Pennsylvania, and upon completion of grade and high schools, joined the student engineering course of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, furthering his education in night school. He was later assigned to the automatic and supervisory control department of switchboard engineering.

In 1928 he joined the engineering department of the Philadelphia Electric Company, and in 1934 transferred to the chief engineer's force of the Pennsylvania Railroad, as chief inspector of substations on electrification projects.

In 1940 he moved to the position of electrical engineer for Alan Wood Steel Company, Conshohocken, Pennsylvania, progressing to assistant chief engineer and to his present position as plant engineer.

Arthur B. Glover was born in Bogard, Missouri, where he received his early schooling, graduating in electrical engineering from University of Missouri in 1926. Following brief periods with Union Electric Light and Power Company and General Electric Company, he became assistant electrical superintendent for Acme Steel Company, Chicago, Illinois.

Henry E. Davis, superintendent of maintenance for Republic Steel Corporation at Buffalo, New York, was born in Kansas and attended Chicago public schools. He began work with Illinois Steel Company at South Chicago in 1900. Following an apprentice course there, he worked at various times for Bussington Cement Company, Inland Steel Company, Wisconsin Steel Company and Colorado Fuel and Iron Company. In 1912 he joined Interstate Iron and Steel Company as chief electrician, and remained through that company's mergers with Central Alloy Steel Corporation and Republic Steel Corporation. In 1935 he was transferred to Republic's Buffalo district.

J. S. LOTHER
BIRMINGHAM DISTRICT

A. D. HOWRY
PHILADELPHIA DISTRICT

A. B. GLOVER
CHICAGO DISTRICT

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*Mr. Mike Verder, Chief Electrician, McEwan Brothers, Whippany, N.J.*

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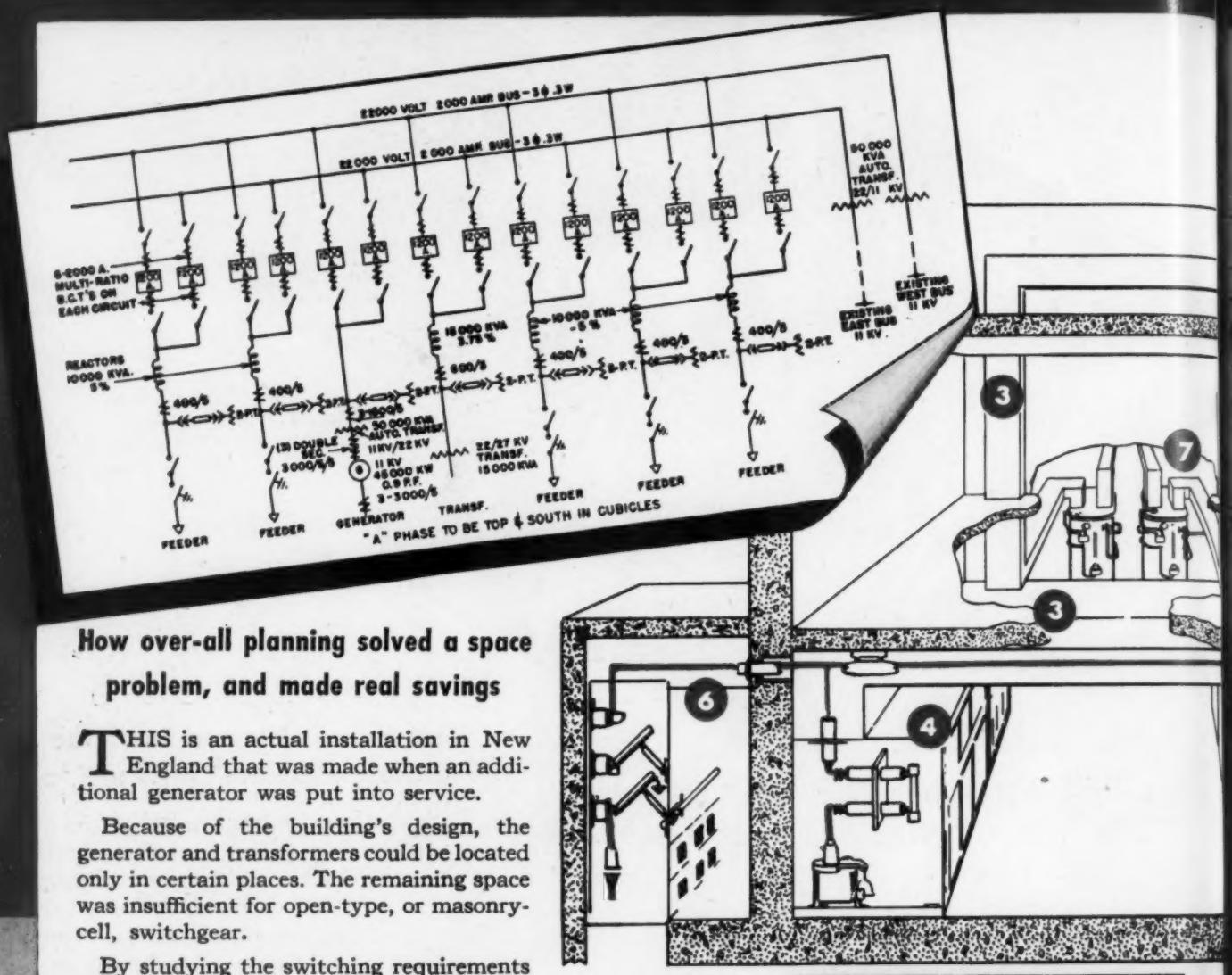


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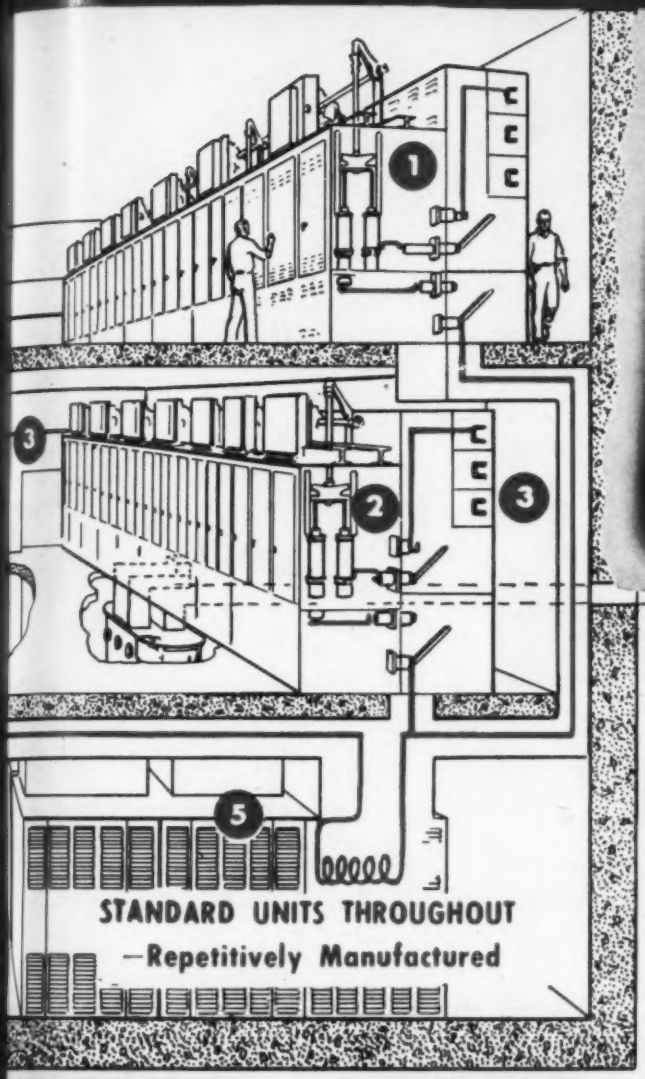


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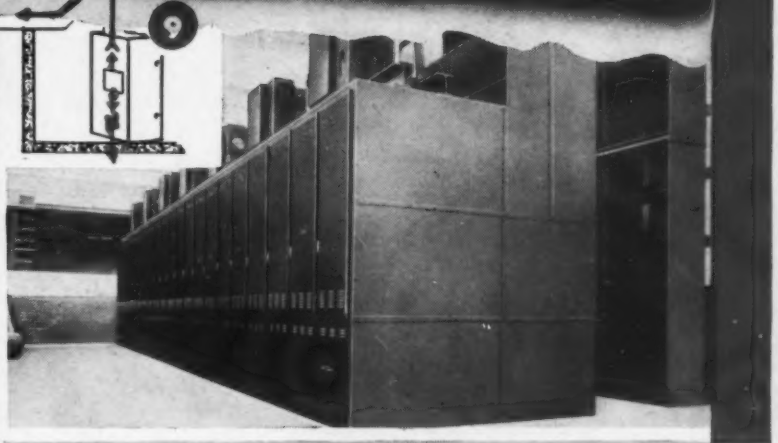

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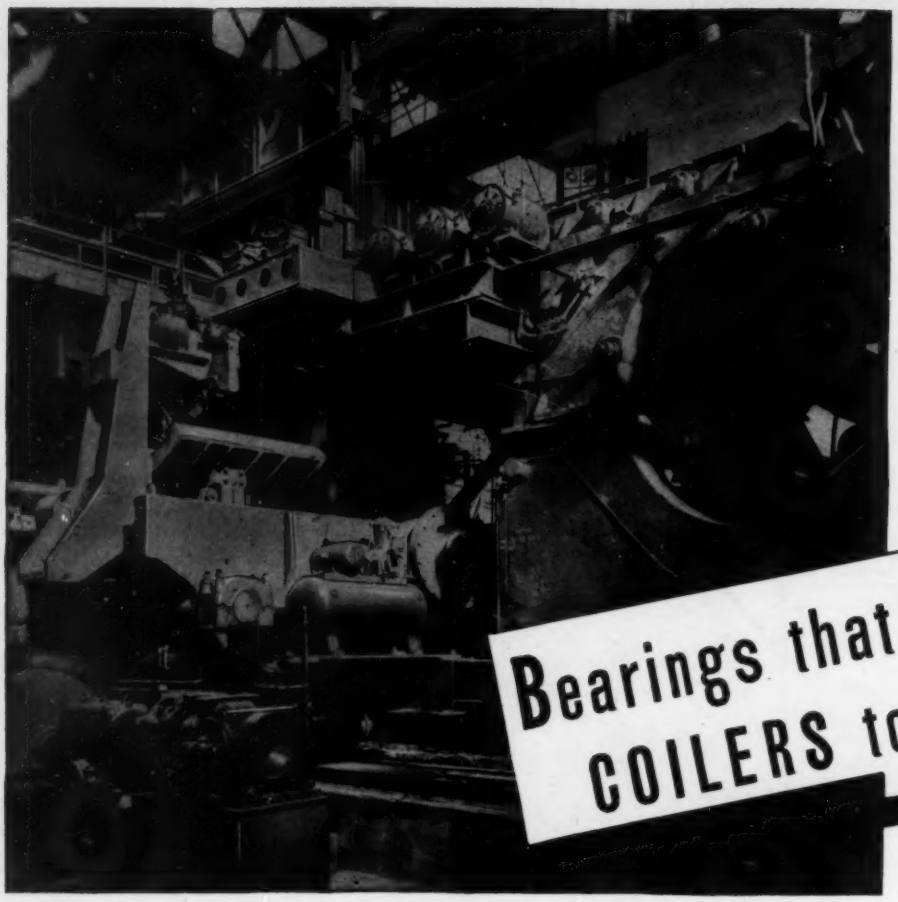

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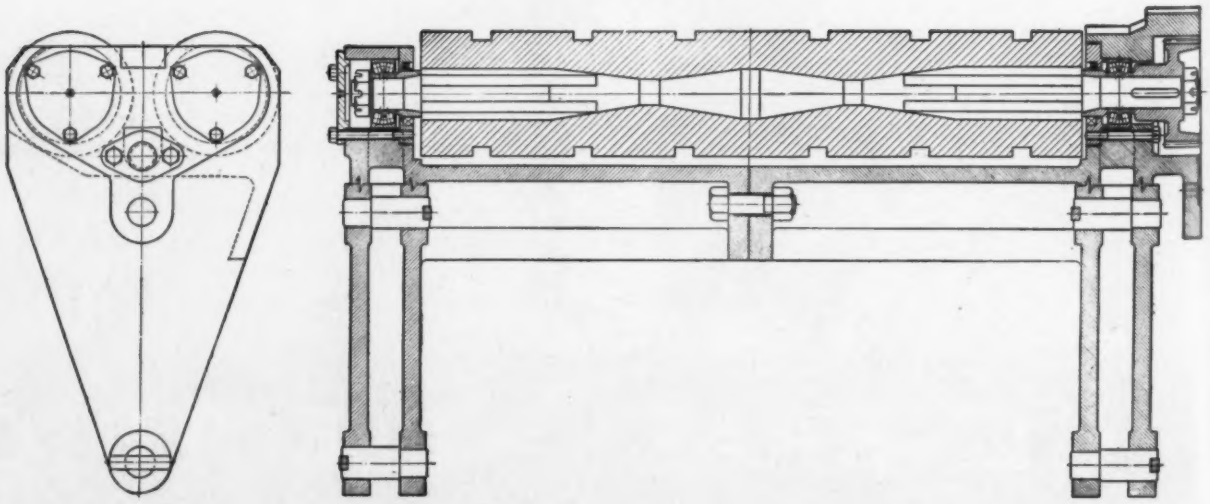

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2. *INCREASED HEAT RESISTANCE—to reduce firecracking and wear;*
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On blooming, roughing, intermediate and finishing operations, they have been tried with marked success. We have also had an opportunity to check their performance on several different metals and alloys. Customers have found them especially economical on the newer high-alloy steels.

We believe you, too, will find these new Birdsboro rolls a decided improvement and would like to have you try them. Ask our roll engineers for detailed information and assistance in applying Birdsboro "Special 'A' DIAMONDITE" Rolls to the particular needs of your operations.

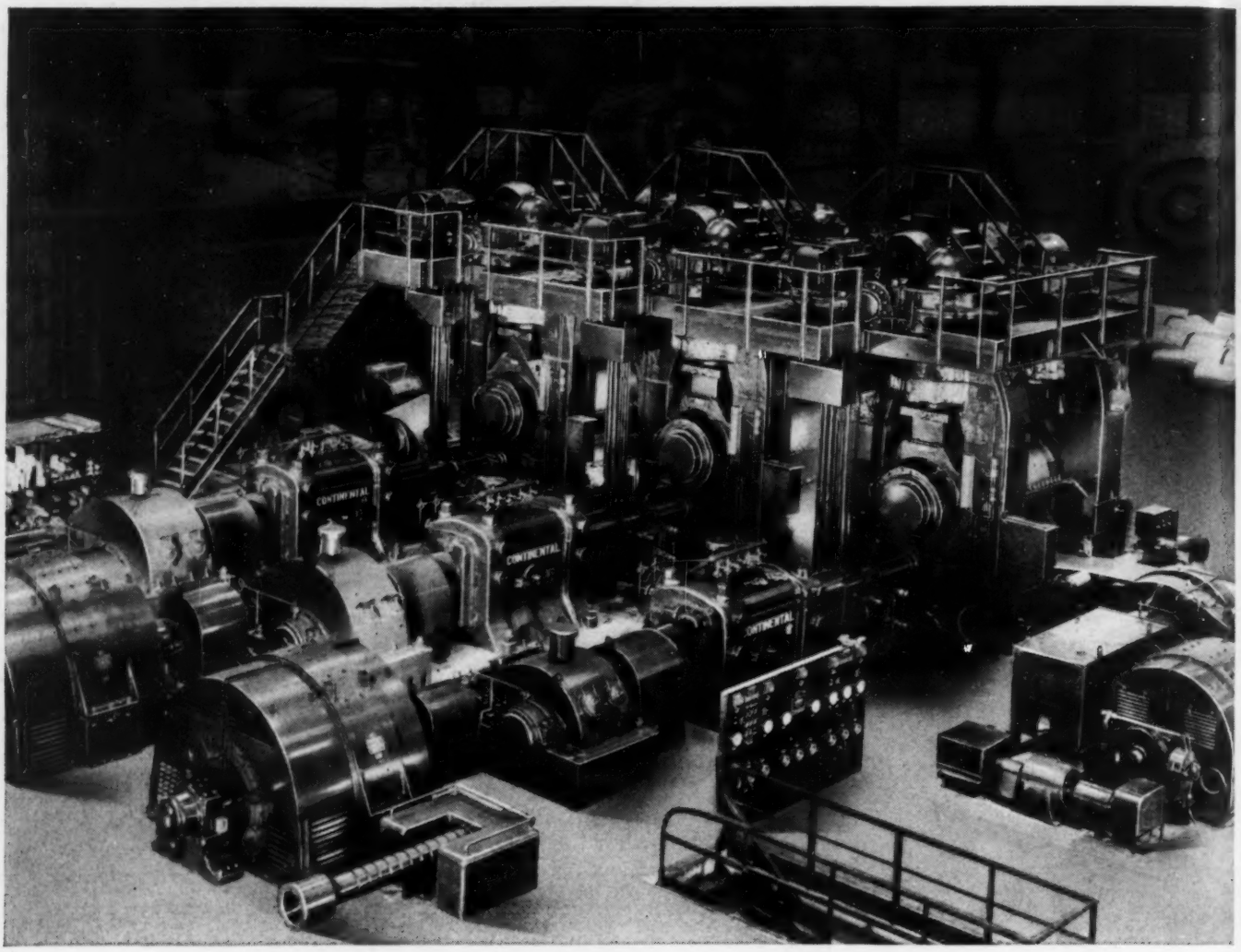
BUY WAR BONDS

BIRDSBORO STEEL FOUNDRY & MACHINE COMPANY • BIRDSBORO, PENNSYLVANIA

**BIRDSBORO ROLLS**

# CONTINENTAL

# 4 HIGH COLD STRIP MILL



**Three Stand Tandem Cold Mill designed and built by Continental. This installation is one of many types of mill units furnished by Continental to the steel industry.**

**Other products include: Rolls, Mill Equipment and Steel Castings.**

CONTINENTAL FOUNDRY & MACHINE COMPANY

CHICAGO · PITTSBURGH

CHICAGO WORKS, EAST CHICAGO, INDIANA

PITTSBURGH WORKS, CORAOPOLIS, PA. · WHEELING STEEL WORKS, WHEELING, W. VA. · WAYWOOD WORKS, WHEELING, W. VA.

MEMO
TO THE STEEL INDUSTRY

*When vital electrical equipment needs reconditioning or repair... Call for*

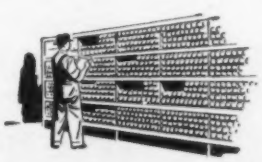
WESTINGHOUSE

FACTORY PROVED

MAINTENANCE SERVICE

**34 MODERN REPAIR PLANTS**—These plants are fully equipped to handle repairs on any electrical equipment, which is not too large to be moved. Equipment includes special apparatus for High Frequency Testing, Dynamic Balancing, Metal Spraying, Phos-Copper Brazing, etc.

**12 ENGINEERING AND SERVICE OFFICES**—Factory-trained engineers are available to diagnose trouble, and work with your own engineers to speed up repairs. Portable field equipment assures accuracy.



**17 RENEWAL PARTS WAREHOUSES** — Conveniently located warehouses can give you prompt service on genuine Westinghouse renewal parts. A Maintenance Engineer is available to discuss any of your problems.

## A Local Service for the Steel Industry

Whenever you need major electrical repairs in your plant—or repair and overhaul of equipment outside your plant—call Westinghouse. A nationwide maintenance organization, with local branches as close as your telephone, is ready to help you get apparatus back on the job in the shortest possible time.

This service offers 3-way flexibility to meet your needs: (1) *A Local Repair Plant*—completely equipped to handle repair and reconditioning of motors, generators, controls, transformers, etc. (2) *Field Engineering and Service* to handle major repair or overhaul jobs right in your plant. (3) *Renewal Parts Warehouses* to give you prompt service on genuine Westinghouse replacement parts.

To obtain any of these services, just phone your nearest Westinghouse Sales Office for a Maintenance Engineer.

J-96005-1

### WHAT "FACTORY-PROVED" MAINTENANCE MEANS

This tag, attached to every repair job handled by Westinghouse, means that the work has been handled according to rigid factory standards. "Factory-Proved" methods and materials have been employed; the apparatus has been tested according to factory specifications; apparatus repairs carry the standard Westinghouse guarantee. This means better, longer-lasting repairs.

WESTINGHOUSE

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

RENEWAL PARTS—ENGINEERING SERVICE—REPAIRS

# S-M-O-O-T-H PERFORMANCE...

**DRUMS! DRUMS! DRUMS!**

War needs make it imperative that all empty drums be returned immediately.

## TYCOL NO-RUST-OLS

*New Powerful Rust Preventives... Engineered for Easy Application*

These new Tycol Rust Preventives solve the problem of rust prevention on: stock in storage, parts in production, and machinery standing in warehouses awaiting reconversion.

Engineered expressly to meet U. S. Army and Navy specifications, their low viscosity and low pour lend themselves to applications — down to 50° F — by spraying, brushing, swabbing or dipping. Compounded from the finest mineral oil base, Tycol NO-RUST-OLS do not dry to a wax-like coating, thus they can be removed by a simple degreasing operation.

If moisture is present — whether from indoor storage, or mild "sweating" during factory handling, call or write your nearest Tide Water Associated office for complete details about the "rust protection" afforded by Tycol NO-RUST-OLS.

TYCOL

**TYCOL INDUSTRIAL**

*ENGINEERED FOR EVERY*

# M-A-X-I-M-U-M EFFICIENCY

## *with* TYCOL

## ENGINEERED LUBRICATION

Under all conditions the proved performance of Tycol lubricants more than meets their recommended service.

Rigidly controlled and tested during manufacture . . . and refined from the highest grade crudes, Tycol oils and greases (whether straight mineral or compounded) retain their uniformity* within each classification – from the first drum to the last. This unvarying high quality, plus the scope of the line, accounts for Tycol's wide acceptance among operators interested in maximum production . . . top efficiency . . . lowest operating cost.

Whatever your lubrication need, there is a Tycol oil or grease expressly engineered to afford greater economy . . . longer machine life for every type of equipment. Let a Tide Water Associated engineer help you select the best one for your particular need. Call, write or wire your nearest Tide Water Associated Office for full details.

*Makers of Famous Veedol Motor Oil*

*** UNIFORMITY.** For clear, concise descriptions of the basic tests used to determine important lubrication properties – Pour Point, Extreme Pressure, Uniformity and many others – consult Tide Water Associated's informative handbook "Lubricania". For your FREE copy write: Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

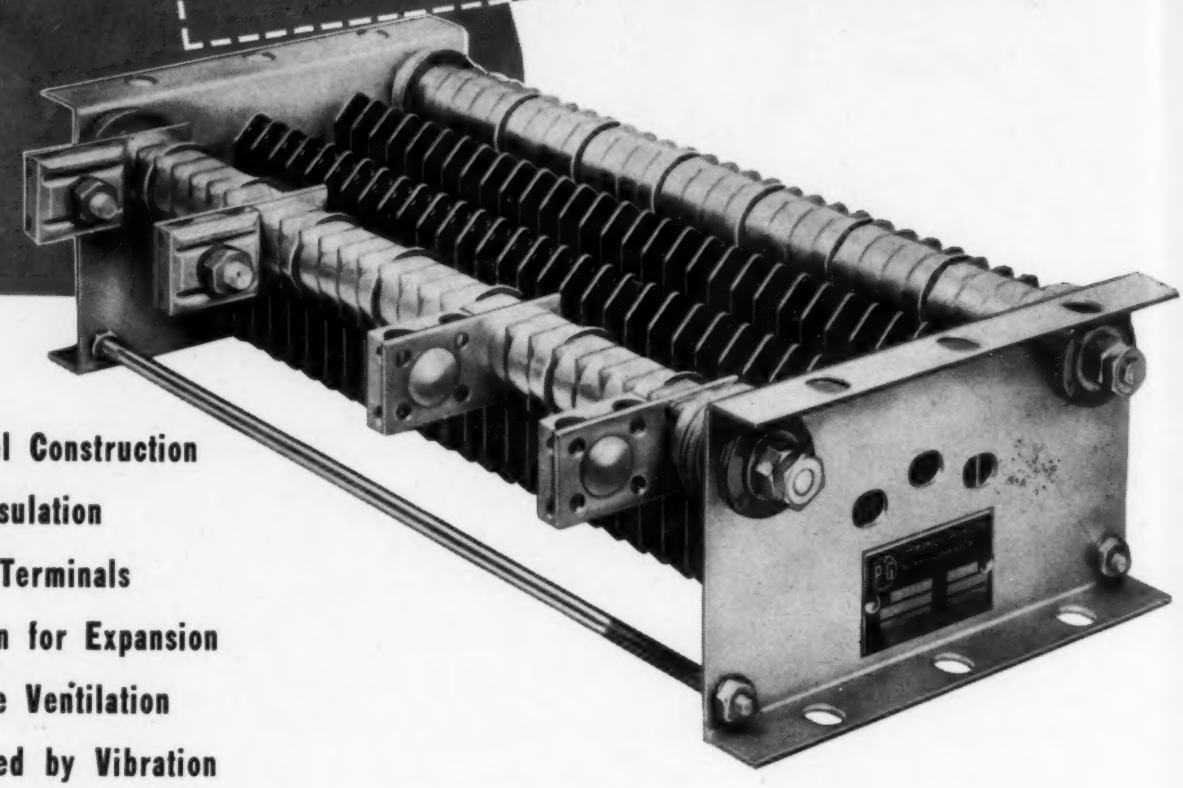
LUBRICANTS
SERVICE NEED

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

PRINCIPAL OFFICES
BOSTON · PHILADELPHIA
PITTSBURGH · CHARLOTTE, N.C.

# POST-GLOVER

**P-G** ... *Nonbreakable* STEEL GRID *Resistors*



**All Steel Construction**
**Mica Insulation**
**Rugged Terminals**
**Provision for Expansion**
**Adequate Ventilation**
**Unaffected by Vibration**
**Moisture Resistant**
**Corrosion Protected**

BULLETIN No. 500
IS AVAILABLE FOR
DETAILED RESISTOR DATA

These Post-Glover Standard Resistor Units will increase production equipment availability thru reduction in motor maintenance and machine hours lost from electrical failures. P-G Steel Grid Resistors are rugged because they are built of steel and mica. Add to this, sound resistance values with ample capacities and failures due to resistor trouble cease to exist. Specify P-G for your next application, especially, if your operating conditions are severe.

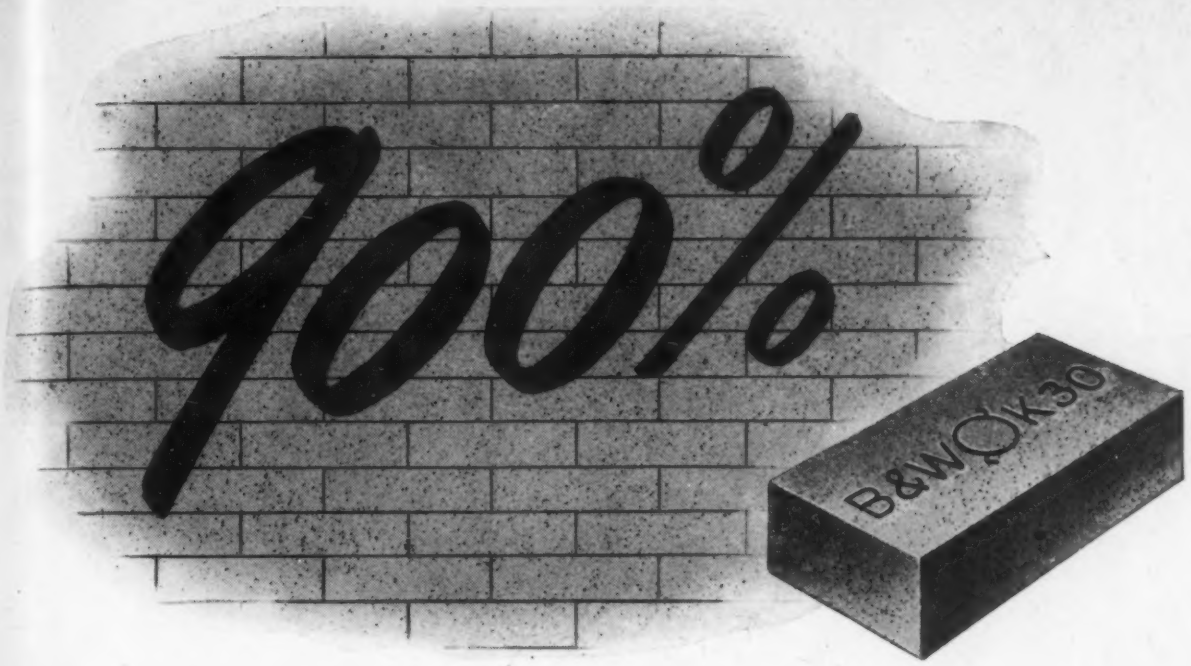
P-G

*The Nonbreakable Steel Grid Resistor*

**THE POST-GLOVER ELECTRIC COMPANY**

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO




# $270. INVESTMENT IN B&W INSULATING FIREBRICK YIELDS $2430. PROFIT

**A prominent steel company had been using first quality fireclay brick in its bar-stock forge-furnaces. A change was made to B&W K30 Insulating Firebrick, at an increased cost per furnace of $270.00.**

**Consumption of fuel oil dropped immediately from 110 gallons per day to 80, a daily saving of $1.80, or approximately $540.00 per year.**

**The average life of B&W Insulating Firebrick in this application is 5 years. The extra cost of B&W K30's is saved in half a year. The savings made during the remaining 4½ years total $2430.00 —an annual return of 180 per cent on the extra investment.**

**Lightest in weight, lowest in heat conductivity, high in hot load strength at maximum service temperatures for which they are recommended, B&W Insulating Firebrick show substantial savings. Specify B&W—and SAVE!**

BABCOCK & WILCOX

BUY WAR BONDS! BUY MORE THAN BEFORE

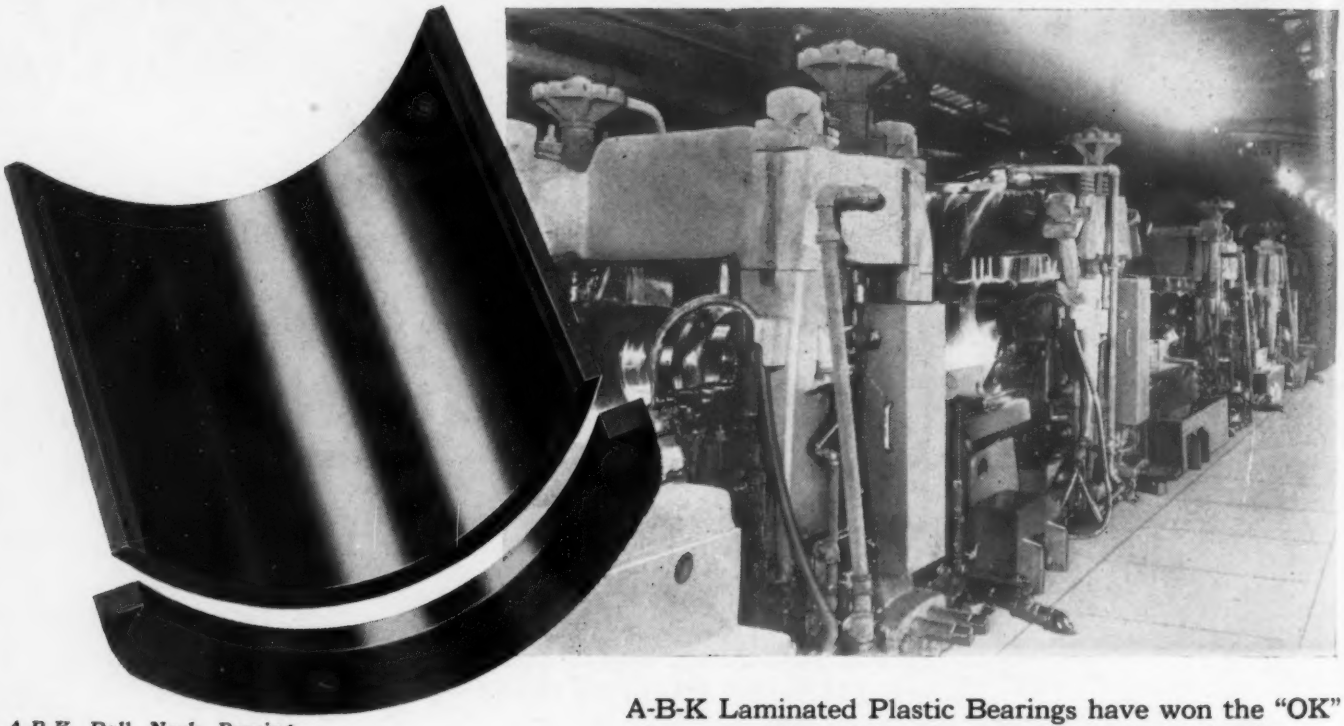
**THE BABCOCK & WILCOX CO.**
*Refractories Division*
85 LIBERTY ST., NEW YORK 6, N. Y.

R-213

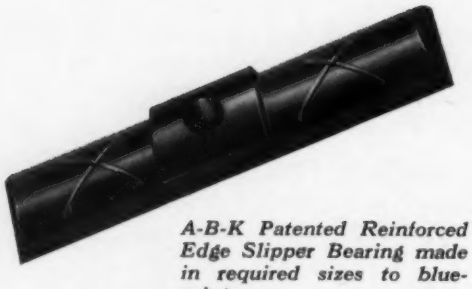
## Tonnage Goes Up—Power Costs Go Down

# A-B-K

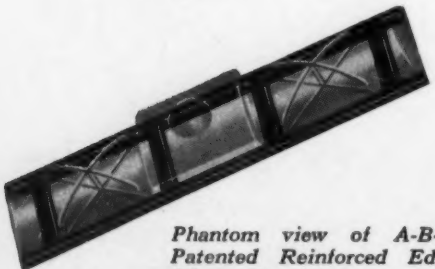
# Laminated Plastic Bearings



*A-B-K Roll Neck Bearing with separate collar.*



*A-B-K Patented Reinforced Edge Slipper Bearing made in required sizes to blueprints.*



*Phantom view of A-B-K Patented Reinforced Edge Slipper Bearing.*

A-B-K Laminated Plastic Bearings have won the "OK" of many mill operators in today's record production.

More tons of steel per set of A-B-K Roll Neck Bearings—often 20 times as much as with metal bearings.

Savings up to 40% in power consumption are common in blooming, merchant and other steel mills using A-B-K Laminated Plastic Bearings.

A-B-K Roll Neck and Slipper Bearings were developed by A-B-K engineers to meet the specific problems of steel mill operators.

For information on your problem, phone, wire or write American Brakeblok Division, Detroit 9, Michigan.

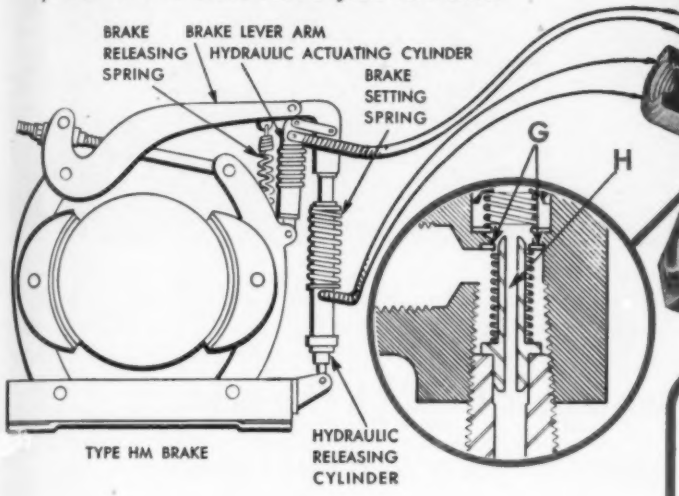
American Brakeblok

DIVISION OF AMERICAN Brake Shoe COMPANY

# Only the Wagner type HM HYDRAULIC CRANE-BRIDGE BRAKE

## provides ALL THREE requirements of a PERFECT BRAKING SYSTEM

1. **FOOT-CONTROLLED HYDRAULIC BRAKE** for service stops
2. **AUTOMATIC SPRING-SET BRAKE** for parking
3. **AUTOMATIC CUSHIONED EMERGENCY STOPS** when power fails or crane runs beyond safe limits



**BRAKE CONTROL UNIT**

COPPER TUBING
TUBING UNION
RUBBER BUSHING
BUSHING CAP
HOSE BRACKET
ARMORED HOSE

IT'S one thing for a crane-bridge brake to set automatically when the power fails—but it is another matter for the brake to set *smoothly* and bring the load to a *cushioned* stop! That's how the Wagner type HM Hydraulic Crane-Bridge Brake stops the bridge and its load: smoothly and safely. There's no jerk, no strain on the machinery, no undue swinging of the suspended load.

A tiny valve in the HM brake control unit is the secret to the cushioned stops. As the cut-away photograph at the right reveals, the hydraulic fluid in the parking-brake cylinder escapes thru a restricted opening, so that the full force of the spring is released at a rate accurately predetermined to provide a smooth, cushioned stop.

The control unit, of which the "Cushion-Stop Valve" is a part, consists of a transformer (A) and a selenium rectifier cell (B) that converts alternating current to 12 volts direct current (the direct-current unit resistors are substituted to reduce the direct-current voltage), a magnetic valve which traps hydraulic fluid in the spring-set brake cylinder, the "cushioned-stop valve", and a pressure switch. The entire unit is simple in design, with very little wear factor and hence very little maintenance involved. The short description at the right will help you to understand how the brake control unit works.

The brake control unit is but one of many features making the Wagner type HM Hydraulic Brake the ideal brake for crane bridges. Among other features are: (1) pushbutton control in crane cab enables operator to set brake as desired, (2) signal light indicates when parking brake is released, (3) brake control can be interlocked with motor pilot-circuit to insure release of brake before starting motor, (4) brake can be set at any time during cycle of crane operation by use of limit switches, (5) can be applied to almost any type of industrial crane equipment.

For a complete discussion of the Wagner type HM Hydraulic Crane-Bridge Brake, read Bulletin IU-186, which we'll gladly send you on request.

**MAGNET (C)** controlling plunger (D) is energized when switch (J) closes line circuit (L).

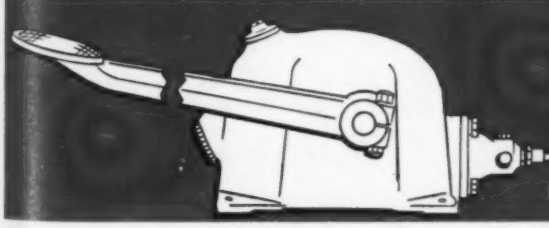
**PLUNGER (D)** closes escape port in sealing cup (F). Fluid entering port (E) passes readily through sealing cup (F), but cannot return while magnet is energized.

**METERING DISC (G)** meters the escape of fluid when magnet is de-energized—thus releasing the spring-set brake at a predetermined rate to effect a smooth, cushioned stop.

**SWITCH (J)** is operated by plunger (I) which is actuated by fluid entering through tube (H). This tube directs the flow of fluid to assure a full release of the spring-set brake before line circuit is closed and magnet is energized.

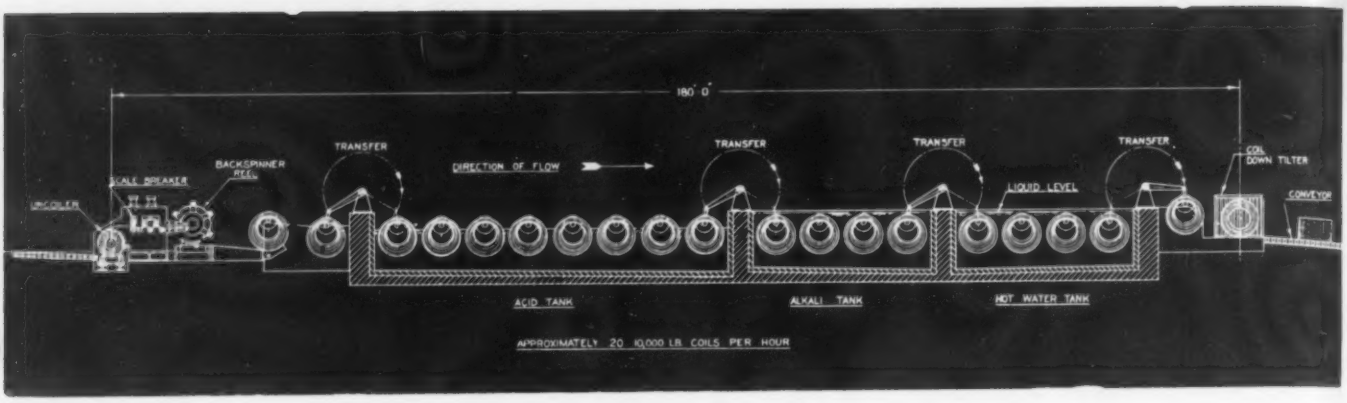
**PILOT CIRCUIT (K)** is completed when line circuit is closed, lighting pilot light in control cab—notifying operator that spring-set brake is released and bridge brake is ready to operate.

145-9



**Wagner Electric Corporation**
ESTABLISHED 1891
6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.
In Canada: Wagner Electric at Leaside, Ontario
ELECTRICAL AND AUTOMOTIVE PRODUCTS

# CONTINUOUS STRIP PICKLING IN COILS




The coils follow each other through the acid, alkali and wash tanks at approximately 20 coils per hour. The frequent aeration of the coils produces a product of superior quality.

**MINIMUM FLOOR SPACE**
•
**LARGE TONNAGE**

**LOW OPERATING COST**
•
**SUPERIOR PRODUCT**

**Subsidiary Company**
**THE TAYLOR-WILSON MANUFACTURING COMPANY**
**McKEES ROCKS, PA.**

**Sole Licensee**
**Under Greer Patents**

# THE ARMS-FRANKLIN CORPORATION

Engineers and Builders of Rolling Mill Machinery

**YOUNGSTOWN 3, OHIO**

NEWS SUPPLEMENT October, 1945

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

## TENNESSEE COMPANY TO EXPAND VARIOUS PRODUCTION FACILITIES

▲ A broad plan for further development of the Tennessee Coal, Iron and Railroad Company's sources of raw materials, including the opening of a new coal mine, was announced recently by Robert Gregg, president of the company.

United States Steel Corporation, of which the Tennessee Company is a subsidiary, has recommended that the company proceed with the program. In addition to the new coal mine, it includes the restoration of two iron ore slopes to production, the construction of an open hearth furnace, and the replacement of a battery of coke ovens to maintain present coke capacity.

The new coal mine will be opened in the American seam in the Concord area. It will produce an estimated 4200 tons of coal per day at its ultimate capacity. Its major features will include a 2200-ft hoisting slope, a 1400-ft material slope, an 18-ft diameter shaft, nine miles of railroad, and the customary surface facilities. Improvements looking toward increased production also will be made at the company's Edgewater and Short Creek coal mines.

The hoisting slopes for ore mines Nos. 8 and 13, out of action for several months, will be placed back in operation. Additional working places will be opened in all the ore mines. Capacity will be raised in limestone mine No. 5 and the dolomite quarry at Dolonah through the addition of mining and quarrying equipment.

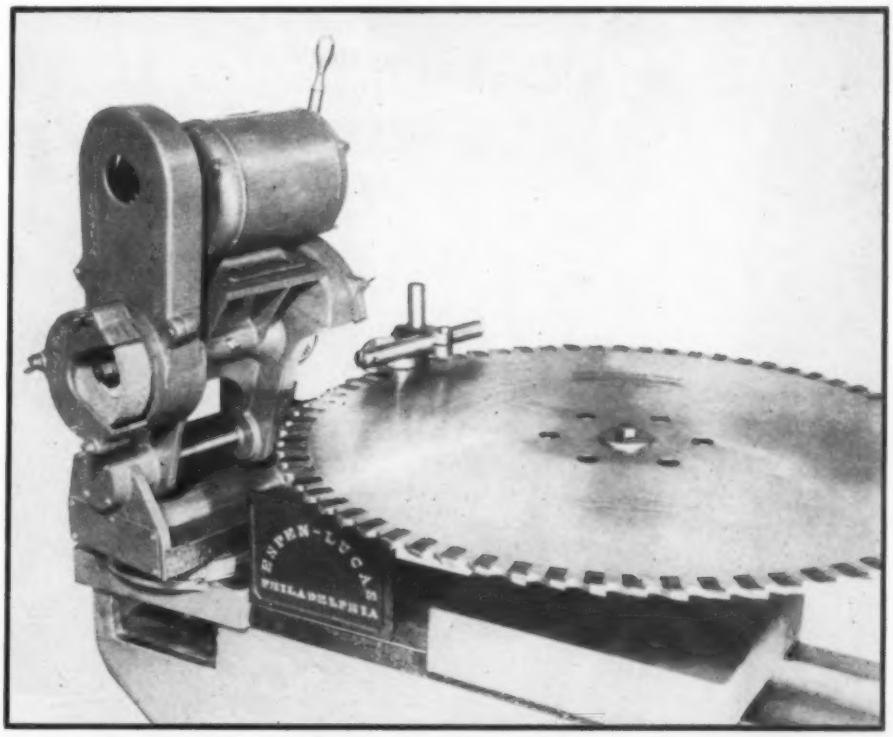
The new battery of 63 modern coke ovens will be installed at the Fairfield Coke Works. This will be in the nature of replacement, Mr. Gregg asserted. One of the older batteries is expected to be removed when the new battery is completed, he explained.

One additional open hearth furnace will be constructed at Fairfield Steel Works, raising the company's steel ingot capacity 120,000 tons per year.

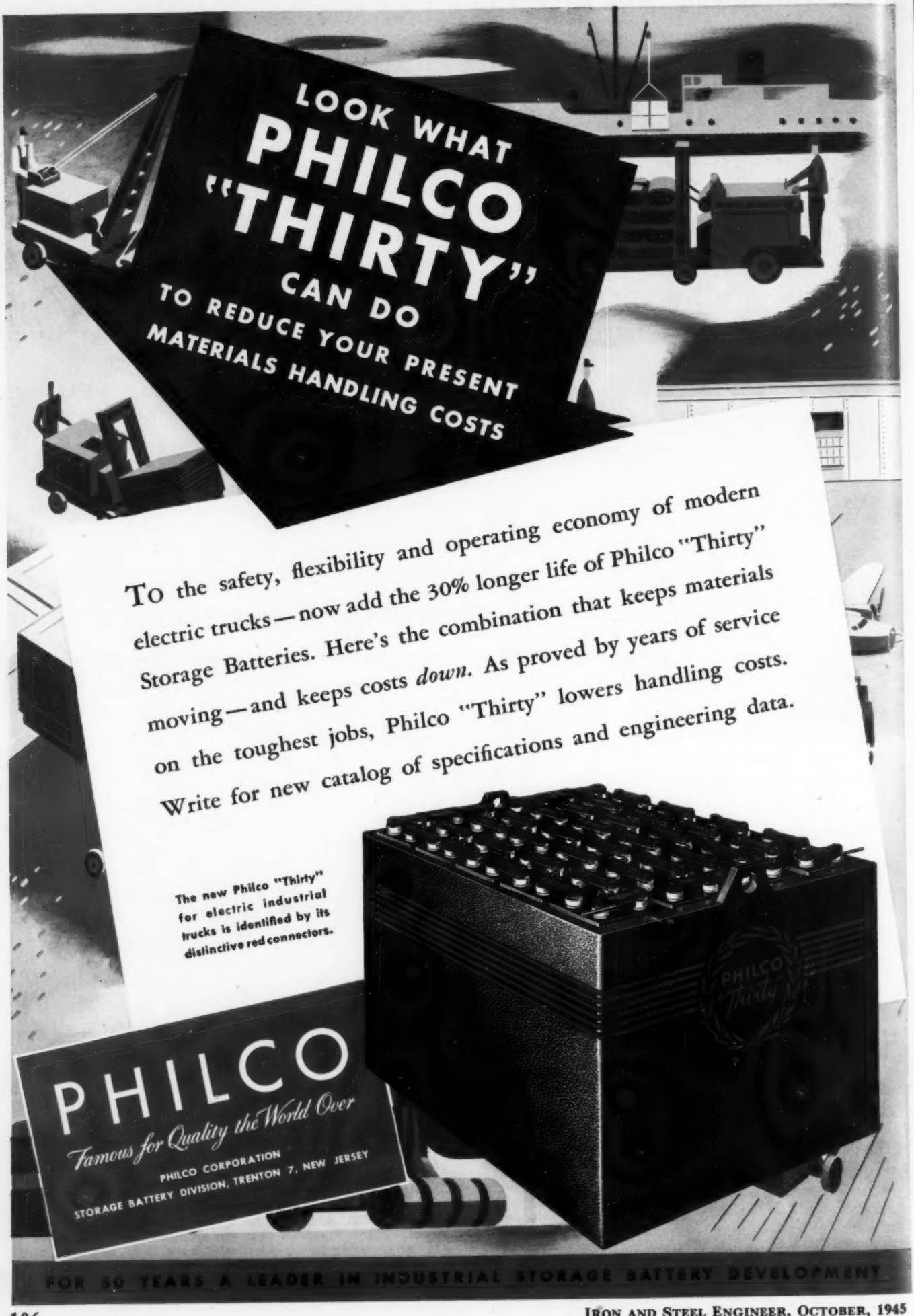
"It always gives me great pleasure to announce development plans for the Tennessee Company to the people of the community in which our mines and plants are located," Mr. Gregg said. "It is a matter of history that this company has never been for long without some sort of improvement, and I trust that its growth will continue. This new program quite obviously will create additional jobs and, incidentally, additional purchasing power in this community. It is indicative, too, of the faith that United States Steel Corporation has in the industrial future of the South."

Work on the project will begin immediately and will require perhaps 18 months for completion.

## SAW BLADE GRINDER OFFERS RIGIDITY, ACCURACY




**A new circular saw blade grinder of unusually heavy, rigid construction for sharpening inserted-tooth metal-cutting saws has been announced by Espen-Lucas Machine Works, Philadelphia, Pennsylvania. The unit is designed to grind teeth accurately and uniformly to within .001 in. and also maintains proper tooth contour. These features ensure greater saw cutting speeds and lengthen intervals between sharpenings. The grinder, Model No. 27, has the capacity to handle blades from 18 in. to 48 in., and can be increased to 60 in. Motor required — ¾ hp, 1800 rpm (approx.). Floor space — 7 ft x 15 ft.**


LOOK WHAT
PHILCO
"THIRTY"
CAN DO
TO REDUCE YOUR PRESENT
MATERIALS HANDLING COSTS
To the safety, flexibility and operating economy of modern electric trucks—now add the 30% longer life of Philco "Thirty" Storage Batteries. Here's the combination that keeps materials moving—and keeps costs *down*. As proved by years of service on the toughest jobs, Philco "Thirty" lowers handling costs. Write for new catalog of specifications and engineering data.
The new Philco "Thirty" for electric industrial trucks is identified by its distinctive red connectors.
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Famous for Quality the World Over
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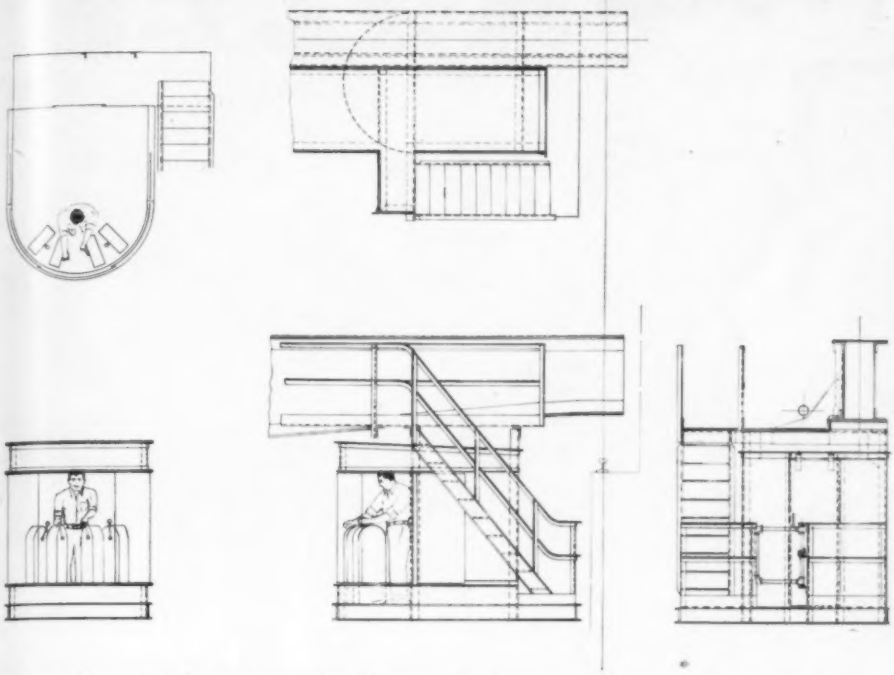
STORAGE BATTERY DIVISION, TRENTON 7, NEW JERSEY
PHILCO Thirty
FOR 50 YEARS A LEADER IN INDUSTRIAL STORAGE BATTERY DEVELOPMENT

## IMPROVED CRANE CAB GIVES SAFETY, CONVENIENCE



**Over the past four years the Morgan Engineering Company has been improving the design of its crane operator's compartment in order to give the operator a clear view of his work as well as of the travel for the full length of the runway. The final development is the design shown in the accompanying sketch, which seems to meet all operating and safety requirements.**

**This design offers many advantages, including the following:**

**(1) The clear view circular front eliminates all blind spots caused by corner angles.**

**(2) Large sliding circular windows are designed to allow ventilation and easy cleaning.**

**(3) Platform on rear with safety gate makes cab accessible and yet does not conflict with operator's vision.**

**(4) Stairway from operator's platform to foot walk on bridge will eliminate ladder hazard and also will not obstruct operator's view either from front or side.**

**(5) The operator's compartment is complete with landing platform, stairway and foot walk extension above the operator's compartment which makes a complete unit.**

**(6) The complete unit is designed and built to meet the heavy service to which steel mill cranes are subjected.**

## ACTIVE CONSTRUCTION IN COKE PLANT FIELD

▲ In addition to contract for 177 by-product coke ovens, consisting of three batteries of 59 ovens each, together with by-product recovery equipment, recently awarded to the Wilputte Coke Oven Corporation, affiliate of Allied Chemical & Dye Corporation, by the National Tube Company, a subsidiary of U. S. Steel Corporation, at Lorain, Ohio, the Wilputte organization is constructing 47 by-product coke ovens for Citizens Gas and Coke Utility at Indianapolis, Indiana. The National Tube project is the largest coke construction contract awarded by the steel industry in recent years.

The Wilputte organization is also active in the coke oven industry outside of the United States, having recently designed a by-product coke oven plant with by-product recovery equipment under construction by Australian Iron & Steel, Ltd. at Port Kembla, Australia. Wilputte is also designing by-product recovery and refining equipment for a large by-product coke plant in Mexico.

Wilputte Coke Oven Corporation has contributed materially in recent years to the advancement of the by-product coke oven industry in the United States through the construction of approximately 700 by-product coke ovens for leading industrial companies. Among companies at whose steel plants by-product coke ovens have been built in the United States are Bethlehem Steel Company at Lackawanna, New York; Republic Steel Corporation at Warren, Ohio, Gadsden, Alabama and South Chicago, Illinois; Carnegie-Illinois Steel Corporation, at Gary, Indiana; and Perry Furnace Company.


LUBRIPLATE
No. 130-A

LUBRICATION PLUS!

A SUPER LUBRICANT—A MARVELOUS ANTI-SEIZE COMPOUND—A REAL PROTECTION AGAINST RUST AND CORROSION. From the standpoints of general utility and wide diversity of important uses, we do not believe there has ever been a lubricant that compares with LUBRIPLATE No. 130-A. It has everything. The outstanding performance of this super-lubricant and its adoption by industry in general, and the Army and Navy are certainly adequate proof of its superiority. Write for copy of bulletin No. 6-41.

LUBRIPLATE
Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE
Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE
Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

*Write for a booklet, "The LUBRIPLATE Film" written especially for your industry.*

LUBRIPLATE
FISKE BROTHERS REFINING CO
NEWARK 5, N. J.
TOLEDO 3, OHIO
OUR 75TH YEAR
1870 - 1945
DEALERS FROM COAST TO COAST

# PRODUCTION "FROZEN"

## ...without *Adequate Plant Wiring*

Urgent boosts in production are more than a matter of manpower, machines and plant floor space. They demand an electrical system that's not "frozen" by outmoded standards . . . that's expandable to meet output increases without costly ripping-out for re-wiring operations.

Adequate plant wiring simply means thoroughness — insistence on ample copper, in wires and cables . . . generous provision of outlets . . . foresighted use of economical high voltage cables and unit sub-stations at load centers.

Foresight pays in wire and cable selection, too. Specify Okolite-Okoprene* wire, for example, in the distribution of power to equipment and benefit by its good performance. It's good because of the excellent electrical properties of Okolite oil-base insulation. It's good because of an outer protective jacket of non-flammable Okoprene which resists moisture and oil as well as abrasion and corrosion. Incidentally Okoprene Sheaths have proved effective for many other uses than power and light wiring, for example: battery cables, control circuits, communication wiring. They also serve as protective covering for Okocord Portable Cords, including welding cables.

Feel free to talk over adequate wiring problems with Okonite engineers — to discuss cable selection, too, with them. The Okonite Company, Passaic, N. J.

*U. S. Pat. No. 2,312,058

**OKONITE**

**insulated wires and cables**

4117

## RESEARCH LABORATORY FOR ALLEGHENY LUDLUM

▲ A postwar research and production expansion program has been approved by the board of directors of the Allegheny Ludlum Steel Corporation, President Hiland G. Batcheller announced today.

An ultra-modern research laboratory and related experimental and pilot plant equipment will be built at company headquarters, Brackenridge, Pennsylvania, to intensify studies of the structure, melting, processing and further development of high alloy steels.

At the West Leechburg, Pennsylvania plant will be constructed a cold rolling mill of latest design, for rolling stainless and silicon strip steels. It will add materially to the capacity of the plant and will bring new precision and uniformity of quality in the production of the special strip steels made there.

## CAN COMPANY TO LOCATE NEAR WEIRTON

▲ Continental Can Company will soon build one of the largest can-making plants in the industry near Weirton, West Virginia on property acquired last week from the Weirton Steel Company, a subsidiary of the National Steel Corporation, according to an announcement by Carle C. Conway, chairman of the board and president of Continental Can Company.

The property of approximately 146 acres is known as the Half Moon Farm. It forms a wide bulge on the Ohio River a short distance downstream from the Weirton mills.

In making this announcement, Mr. Conway pointed out the obvious advantages of locating a plant of this size "next door" to one of its main supplies of tin plate. He also said that an important contributing reason was the good neighborly relations that exist between the Weirton Steel Company and the community.

J. F. Egenolf, Continental's vice president in charge of manufacture, revealed that the new plant will employ between a thousand and 1500 men and women of all grades of skill. Plans for the new building are now being developed, and construction will begin as soon as arrangements can be made. The plant will specialize in general line can manufacture.

Initial equipment will be brought in from Continental's two Wheeling, West Virginia plants and two others located elsewhere, all four of which will ultimately be closed. Employees of the two Wheeling plants have been informed of the company's plans, and every effort will be made to absorb them. Plans have not yet been announced regarding the other two plants.

Construction of this new plant will represent Continental's most important addition to the metal can end of its business since its acquisition of the Owens-Illinois Can Company last year. In the meantime, however, the company has begun construction of a $745,000 addition to its Tampa, Florida plant, and is in the process of enlarging can-making operations in a number of other can plants. Similar additions are now being made to paper plants in Van Wert, Ohio and Reading, Pennsylvania, and to the company's plastics plant in Cambridge, Ohio.

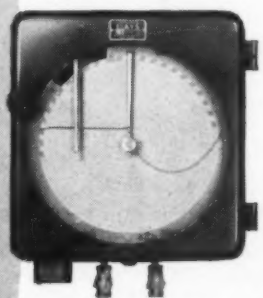

FOR BETTER STEEL

and more of it... use this SIMPLE AUTOMATIC CONTROL

These Hays instruments may be used individually or in combination . . .

TYPE CDE-X FURNACE PRESSURE CONTROLLER with external manual adjustment for automatically operating stack damper to hold pressure constant.

SERIES FOT PRESSURE INDICATOR an easy-to-read measurement of furnace pressure; usually connected at furnace roof.



SERIES OT PRESSURE RECORDER a daily 24-hour record of furnace pressure shows timing of eversals and each change of pressure made by operator during the heat.

A VITAL FACTOR in producing better steel—and more of it—is the automatic regulation of open hearth furnace conditions by means of Hays Pressure and Temperature Control. Operators are relieved of many time-consuming details, have more time for the more important business of making steel.

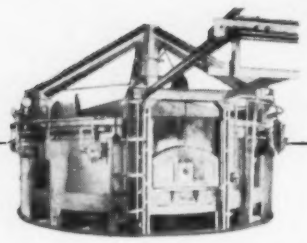
Hays Automatic Pressure Controller is simple to install, easy to understand and to operate. When desired, control can be done manually from a central panel through remote operation.

It's important to know about Hays partial or complete instrumentation. A Hays engineer can tell you all about it—representatives in all principal cities of United States and Canada. Phone or write.

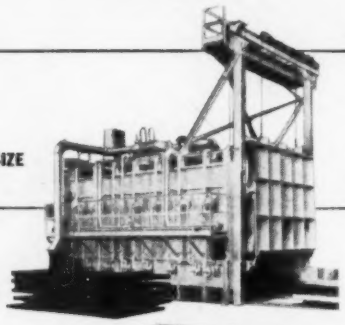
The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
1945 SHIRL AVENUE
MICHIGAN CITY, INDIANA, U.S.A.

# TATE-JONES

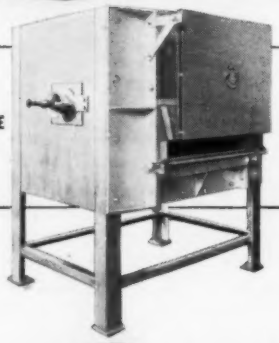
## INDUSTRIAL PLANT ENGINEERS



ANY TYPE



ANY SIZE



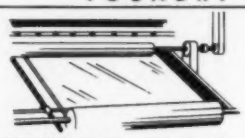
ANY PURPOSE

STEEL MILLS

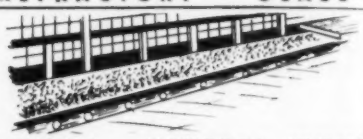
COAL LIMESTONE

FOUNDRY

REFRACTORY GLASS

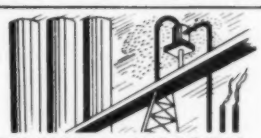


WINDOW GLASS

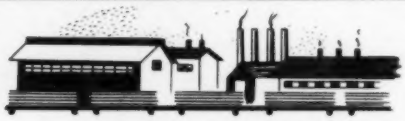


GLASS WOOL MINERAL WOOL

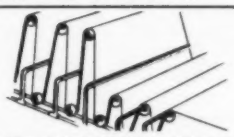
ROCK WOOL FELDSPAR



CEMENT & GYPSUM



ROOFING AND LINOLEUM INDUSTRIES



# SERVES all INDUSTRY

Experience—that's the key to efficient furnace engineering—and that's fundamental. To obtain this experience, it is necessary to run the gauntlet of small installation, and experimentation. But, when a long record of outstanding achievements has been established and recognized, the most valuable asset of business is possessed. For years—in fact for forty-eight years—Tate-Jones has designed, installed and set into operation, hundreds of complete installations for all types of industry.

The name Tate-Jones is today recognized as synonomous with the best heat treating practices and the most up-to-the minute equipment known in industry. For a complete analysis of your engineering problems, or literature on any of our services, write directly to Tate-Jones & Co., Inc., Pittsburgh.

## TATE-JONES *and* company, inc.

**PLAZA BUILDING, PITTSBURGH 19, PENNSYLVANIA**

Gas and Oil Fired • Electric • Pusher • Variable Speed Conveyor • Rotating Hearth • Car Bottom • Roll Down • Horizontal and Vertical Pit • Circular and Rectangular Pot Furnaces • Oil, Gas and Combination Burners • Steel Fabricators

*Equipment for Cycle Annealing · Austempering · Martempering · Pyrrelligizing*

INDUSTRIAL FURNACES TJ ESTABLISHED 1898

## C-W MOTORS NOW AGREE WITH A. I. S. E. STANDARDS

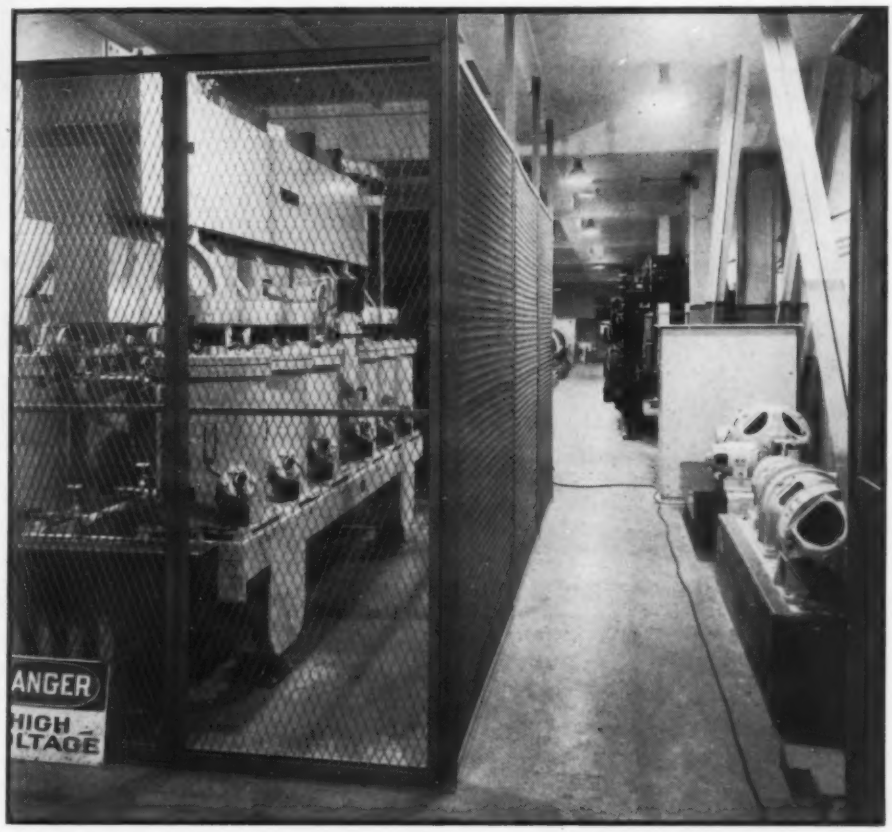
▲ The Crocker-Wheeler Electric Manufacturing Company, division of Joshua Hendy Iron Works, have completed the work in making changes to their standards for Crocker-Wheeler mill motors in order to bring them in line with the standards of the Association of Iron and Steel Engineers.

In addition, to easily associate Crocker-Wheeler frame sizes with A. I. S. E. frame sizes for the short motor, Crocker-Wheeler short motors will be designated 2W5, 3W7½, 4W10, 6W15, 8W25, 10W35, 12W50, 14W75, 16W100, 18W150. It will be noticed that these designations tie in with the A. I. S. E. sizes 2, 3, 4, 6, 8, 10, 12, 14, 16 and 18 respectively. The long frame motors which correspond with the same sizes will remain as heretofore, and as follows SW-5, SW-7½, SW-10, SW-15, SW-25, SW-35, SW-50, SW-75, SW-100 and SW-150. The long motor designation has not been changed as the long motor is generally not being used. The new frame sizes will appear on all Crocker-Wheeler drawings, dimension prints, and literature.

## WHITING LICENSED FOR CUPOLA TUYERES

▲ The Whiting Corporation, Harvey, Illinois, has concluded arrangements with the British Cast Iron Research Association for the exclusive rights to manufacture and market Balanced Blast Tuyeres for cupolas, as previously supplied by the McWane Cast Iron Pipe Company of Birmingham, Alabama.

## D-C POWER FROM RECTIFIERS FOR DRIVE MOTORS




**This photo shows a 2,500-kilowatt Westinghouse Ignitron rectifier in the merchant mill motor room at the Fontana, California, steel plant of the Kaiser Company, Inc. Comprising twelve 15-inch Ignitron tubes arranged in two rows of six each, this installation changes alternating current to direct current for 14 main drive motors. Operating requirements here are such that when starting the merchant mill direct current main drive motors, the rectifier voltage must be reduced to a very low value. This is accomplished by means of a mechanical phase shifter, capable of providing phase shifts of from 0 to 180 degrees lagging, and a second phase shifter of the saturable reactor type. The latter provides for a phase shift in excitation circuit between 0 degrees and 45 degrees lagging, corresponding to a voltage reduction by phase shift control of approximately 25 per cent. Automatic control of the rectifier voltage over this range is provided by a voltage regulator whose regulating resistance is connected in series with the direct current windings of the excitation phase shifting reactor which, by a variation of the direct current and the reactance of these reactors, varies the point on the alternating current voltage wave by which the rectifier fires, thereby controlling the direct current voltage output of the rectifiers.**

WARE HI-LAG

Keep Motors Humming

STRONG FIBRE BRIDGES

Add Extra Strength—Longer Life
And Are Easily Replaced

100% Quality

APPROVED BY UNDERWRITERS

WARE BROTHERS

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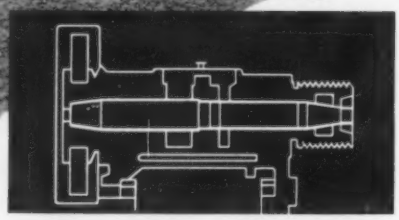
WARE

Renewable

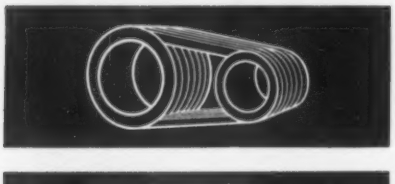
HI-LAG FUSES

# WHY FARREL ROLL GRINDERS MAINTAIN OPERATING ACCURACY

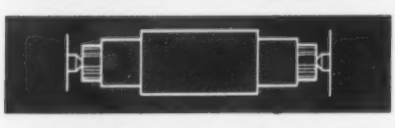
These five vital features are typical of the precision design and construction which give Farrel Heavy Duty and Type TT Roll Grinders their ability to maintain extreme accuracy with a high rate of output:



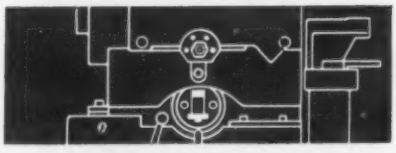
1. GRINDING WHEEL SPINDLE — Of large diameter for rigidity under working load—made of high grade alloy steel, heat-treated and precision ground—mounted in adjustable bearings, automatically lubricated.



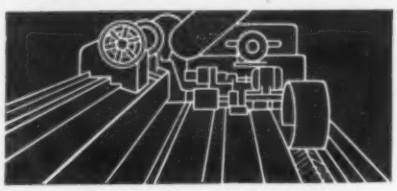
2. WHEEL SPINDLE AND HEADSTOCK DRIVES — Work and wheel are both driven through multiple V belts. Their smooth, vibrationless transmission of power safeguards precision.



3. TWO DEAD CENTERS—Dead center in the headstock as well as in the footstock insures concentric rotation of the work, which contributes to precision grinding of journals and bodies.



4. AUTOMATIC CROWNING AND CONCAVING DEVICE — This built-in "brain" automatically produces a mathematically accurate curve for either a crowned or concaved roll, with both halves perfectly symmetrical. The same setting invariably produces exactly the same curvature.



5. INVERTED V WAYS — Cast separately from the bed, of hard alloy iron, they are exceptionally resistant to wear, maintaining their accuracy for a long life. Automatically flood-lubricated and covered by flexible metal guards to exclude dirt and grit.

**FARREL ROLLING MILL MACHINERY**

- Rolls
- Rolling Mills
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- Universal Mill Spindles
- Rod Coilers
- Gears
- Gear Drives of any Capacity
- Mill Pinions
- Pinion Stands
- Flexible Couplings
- Roll Grinding Machines
- Roll Calipers
- Lead Presses for Pipe or Rod

*Write for catalogs giving complete information.*

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## ARMCO, RUSTLESS DRAW UP MERGER AGREEMENT

▲ Charles R. Hook, president of The American Rolling Mill Company and chairman of the board of directors of Rustless Iron and Steel Corporation, announced that at meetings of the boards of directors of the two corporations held recently, resolutions had been adopted by each board authorizing the officers of the two corporations to proceed with the preparations of an agreement providing for the merger of Rustless into Armco, on the basis of one share of common stock of Rustless not owned by Armco, being changed into one share of common stock of Armco; such merger, subject to stockholders' approval, to become effective at the year-end.

Mr. Hook further stated that Armco intends, after the merger has become effective, to operate the Rustless plant at Baltimore, Maryland, as the Rustless Iron and Steel Division.

## WELDING TO SPEED PEACETIME PRODUCTION

▲ Welding will play an important role in America's industrial future as a means of fast production and of making possible the streamline designs that engineers are projecting for consumer and industrial goods of the future, according to Charles H. Jennings, internationally known arc welding authority and a research engineer with the Westinghouse Research Laboratories.

Speaking in New York to members of the New York Section of the American Welding Society, Mr. Jennings said that welding principles tested in the war program will enable experts to meet and solve the many welding distortion problems of the peacetime production line.

The engineer termed distortion one of the major problems of welding. Heating and cooling of the metal within the area being welded, and the contraction of the filler metal during the cooling period causes the fabricated structure to shrink or warp.

However, by properly studying the fundamental factors producing distortion and applying corrective measures — clamping the parts in fixtures during welding, pre-distorting the parts to compensate for expected distortion, or developing special welding techniques — distortion can often be held to a very low point or entirely eliminated.

War-needed tanks, guns and other armaments were saved from the scrap heap and rushed to our fighting forces through the ability of welding engineers to overcome problems of distortion. In one instance, 100 gun parts were saved by welding on additional metal.

Although seemingly a simple solution, it required a full knowledge of welding theories and application to make this particular job possible, the speaker said. The more difficult problems of distortion are caused by the welding process itself, which through its very nature causes fabricated parts to shrink and warp.

The construction of an all welded ship calls for a pre-determined sequence in the welding of the metal plates so that the stresses built up during fabrication will be balanced. The same problem is true of small assemblies such as parts for airplanes, according to Mr. Jennings.

Cross section of Kemp Immersion Heating element showing tubular construction and method of flue gas travel.

**KEMP IMMERSION MELTING**

***Heating Units are Inside the Metals Heated thus Effecting a 40% Saving in Fuel.***

Blanket of exhaust gases over molten metal surfaces minimizes dross formation. This operation combined with KEMP close temperature control greatly increases efficiency and prevents waste.

These Immersion Melting units are adaptable for the following purposes: melting of all soft metals, lead, tin, pewter and solder—the heating of compounds, stereotyping and electrotyping—lead baths for annealing and tempering—tin coating, lead coating and battery grid casting.

*A Special Bulletin E 200.1 has been prepared giving most complete information. Complimentary copy will be forwarded upon request.*

★

*Numerous Other Kemp Products Include:*

ATMOS GAS PRODUCERS, NITROGEN GENERATORS, FLAME ARRESTORS, INERT GAS PRODUCERS, DYNAMIC DRYERS, INDUSTRIAL CARBURETORS, INDUSTRIAL BURNERS, FIRE CHECKS, STEREOTYPE POTS.

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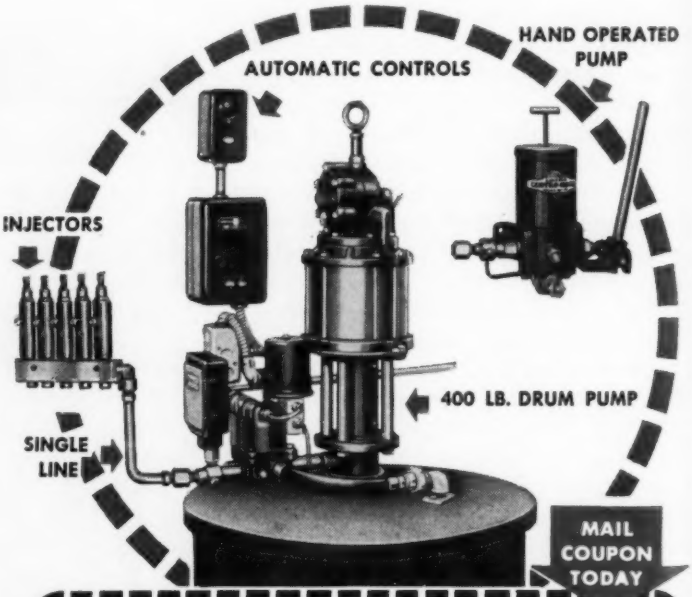
**The C. M. KEMP Manufacturing Co.**

**405 E. OLIVER ST.** **BALTIMORE 2, MD.**

# Check and you'll find Why LINCOLN CENTRO-MATIC Single Line LUBRICATING SYSTEMS are the FIRST CHOICE

Today, Lincoln Centro-Matic Lubricating Systems are being used on all types of machinery and industrial equipment. They are outstanding systems and include many exclusive features. You, too, can save man hours, machine hours, power, bearings, and prevent accidents by installing Lincoln Centro-Matic Lubricating Systems. Check and you will find why Lincoln is the FIRST CHOICE.

- ☑ **1.** Lincoln Centro-Matic Systems will dispense either oil or grease.
- ☑ **2.** Will dispense a pre-determined, measured quantity of lubricant, unaffected by temperature or viscosity changes.
- ☑ **3.** Lubricant is delivered through an injector to each bearing at maximum pressure regardless of location on the machine.
- ☑ **4.** Injectors are easily adjusted for the desired output—no special tools needed.
- ☑ **5.** Each injector is provided with an external indicator.
- ☑ **6.** A complete range of lubricant pumping units adaptable to the bearing requirements of a single machine or a battery of machines. Pneumatically, electrically or manually operated.
- ☑ **7.** Centralized or zoned systems, pumping lubricant from an original refinery container and supplying lubricant automatically at fixed time intervals.
- ☑ **8.** All pumping units are of proven design and incorporate features that have been used on Lincoln lubricant pumps that have served dependably in automotive, agricultural and industrial applications.
- ☑ **9.** Systems can be installed so that lubrication can be effected by the operator either by operating a manual pump, opening a valve on a common lubricant line under pressure, or from a time-controlled central source.
- ☑ **10.** Easy to install. Only one supply line is needed.
- ☑ **11.** Any injector in a manifold can be removed for inspection without disturbing line connections or other injectors in the manifold.
- ☑ **12.** Special Linpak packing eliminates metal-to-metal seals. This maintains accuracy and gives longer service life.
- ☑ **13.** The facilities of Lincoln Engineering Company are devoted exclusively to the manufacture of lubricating equipment.
- ☑ **14.** A staff of experienced lubrication engineers is ready to assist you in all lubrication problems.

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*Pioneer Builders of Engineered Lubricating Equipment*
5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.

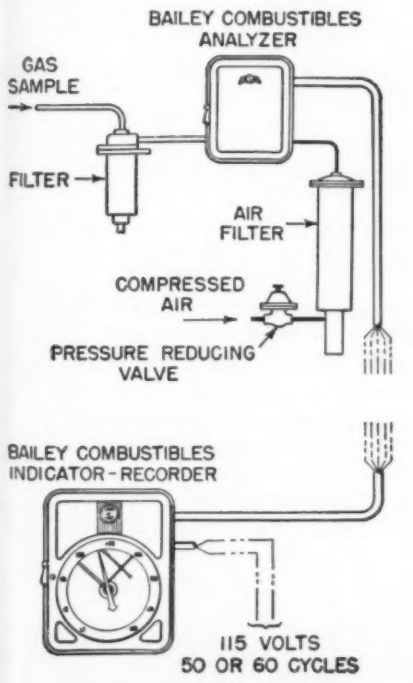
## ANALYZER RECORDS, CONTROLS COMBUSTIBLES

▲ A new automatic analyzer and recorder for indicating, recording and controlling the combustibles content of a gaseous mixture, has been developed by the Bailey Meter Company, Cleveland 10, Ohio. This instrument has been successfully applied to precision control of furnace atmospheres and chemical processes, as well as combustibles measurements in the petroleum, metallurgical, automotive, and chemical industries.

The analyzer and recorder provide a continuous graphic analysis almost instantly, and they are said to be responsive to changes of .05 per cent combustibles. Sustained accuracy is said to be within .25 per cent.

A continuous gas sample is mixed with compressed air and burned on a catalyst-filament which reaches a temperature proportional to the combustibles content. Since the filament resistance is a function of temperature, a simple resistance bridge connected to a null-balance electronic recorder completes the installation. It may be calibrated in per cent combustibles, mixture ratio, or other desired terms.

Pneumatic control or electric alarm contacts may be provided on both one and two-pen recorders. A two-pen recorder utilizes separate analyzers so that the speed is not impaired by switching, and the two records are independent of each other.




Combustibles recorder-controllers applied to process furnaces operating with reducing atmospheres are said to permit finer measurement and control than has heretofore been considered possible. This results in greater uniformity and higher quality of product, as well as greatly increased furnace economy. Variable fuel quality does not affect the accuracy of control on installations of this type.

## BOOM ATTACHMENT WIDENS TRUCK USE

▲ A simple, easily constructed boom attachment enables a machine tool builder to use an Elwell-Parker high-lift platform truck for a wide range of "intermediary" transportation jobs.

Raw materials and light and medium-weight parts are transported in skid boxes by means of platform trucks. Weight of the individual loads vary from a few pounds up to 3 tons or more. Heaviest castings for the type of machines the company builds weigh up to 20 tons, and are handled by means of an overhead traveling crane.

Many castings and parts for machine tools are of a size or shape not readily handled on skids or in skid boxes, and they must be transported to other buildings or to stations not reached by other equipment such as overhead traveling cranes. The machine tool builder adapts his platform trucks to these loads by means of a detachable boom built from steel angles and rods.

The truck's platform is driven underneath the device and a latch bar on the attachment is engaged with a cross member of the truck's elevating mechanism, which holds it firmly while a load is being lifted and transported. The attachment can be applied or removed in a few minutes.

This improvised boom gives satisfactory service, the machine tool builder reporting that it has already saved many times its cost in time and manpower.

Elwell-Parker Electric Company, Cleveland, builds a detachable boom for use with its trucks, which has a separate motor for elevating and lowering the load by means of a cable. The lead from this motor can be plugged into the truck's regular battery equipment.

## PROTECTED MOTOR LINE BROADENED

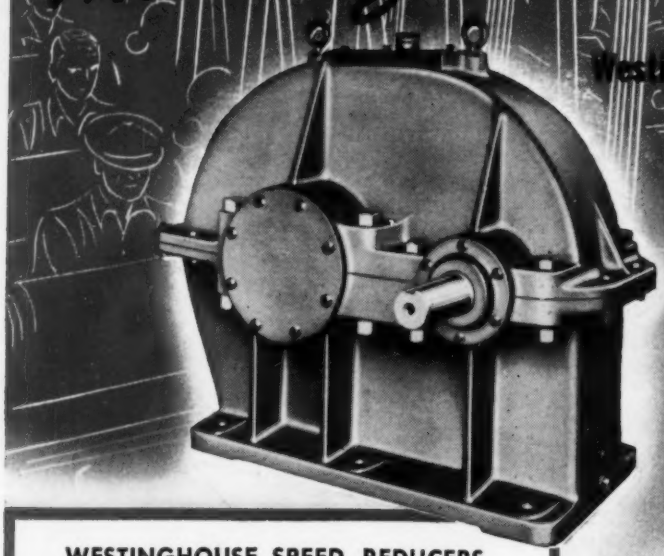
▲ The Crocker-Wheeler Division of Joshua Hendy Iron Works, Ampere, New Jersey, announces a new addition to the company's line of Protected-Type a-c motors. The newcomer, a vertical dripproof motor which is rated at 40 C rise continuous duty with a 15 per cent service factor, is designed for operation from 60 or 50 cycle, 3 or 2 phase circuits at all standard voltages. At present a NEMA "B" flange type mounting up to and including the "284" frame, and a NEMA "C" face type mounting up to and including the "326" frame is available.

All ventilating openings of this new line of motors are shielded against the entrance of dripping liquids and falling particles. Oversize ball bearings are provided to carry thrust in addition to the rotor, and the use of the company's patented centrifugal bearing seal permits the use of softer grease for better lubrication and longer bearing life.

A new recessed junction box, which provides ample room for making electrical connections, is employed in the motor's design. The Crocker-Wheeler Alucast rotor, with bars, fans and end rings cast in one operation from aluminum alloys, is used. Other features include: heavy cast frame construction and coils protected with Vinylastic insulation.

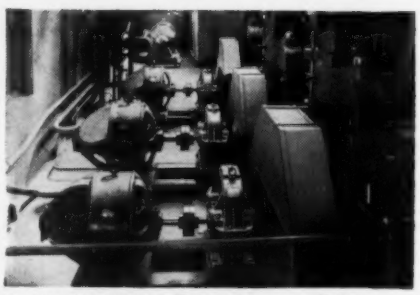
# Modernize with "Packaged Drive"

## Westinghouse SPEED REDUCERS and Gearmotors

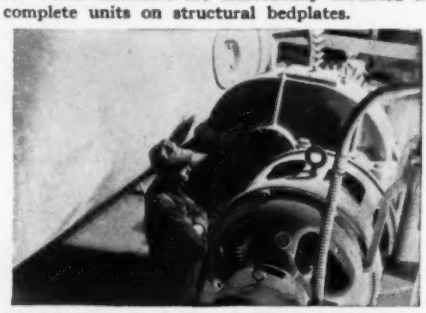


Save Space
Reduce Power Costs
Increase Safety
Reduce Maintenance
Improve Appearance

### WESTINGHOUSE SPEED REDUCERS MAKE COMPACT DRIVES



**IN PAPER MILLS.** For maximum efficiency and long, trouble-free service, these Tandem Drives for board calenders are individually mounted as complete units on structural bedplates.



**IN CEMENT PLANTS.** A Westinghouse Speed Reducer provides power at 145 rpm from a 100 hp, 870 rpm motor. Complete Westinghouse Equipment here, assures undivided responsibility.

**IN STEEL MILLS.** Type DH-18 Westinghouse Speed Reducer provides reliable power to a single-chain type drawbench from a 75 hp, 570 rpm motor.

### Save time with Simplified Ordering . . . Simplified Installation . . . Simplified Maintenance

For drives up to 1000 hp, the Westinghouse Speed Reducer—complete with Westinghouse motor—makes a high efficiency drive "package" which is "a natural" for reconversion.

The advantages of speed reducers stem from two major features: (1) reduced losses, because power is transmitted through fully enclosed gears with shafts anti-friction bearing equipped; (2) longer life and reduced outage time... because maintenance seldom amounts to more than oil changes.

Other reasons for the high efficiency of Westinghouse Speed Reducers are the precision manufacturing methods employed, such as:

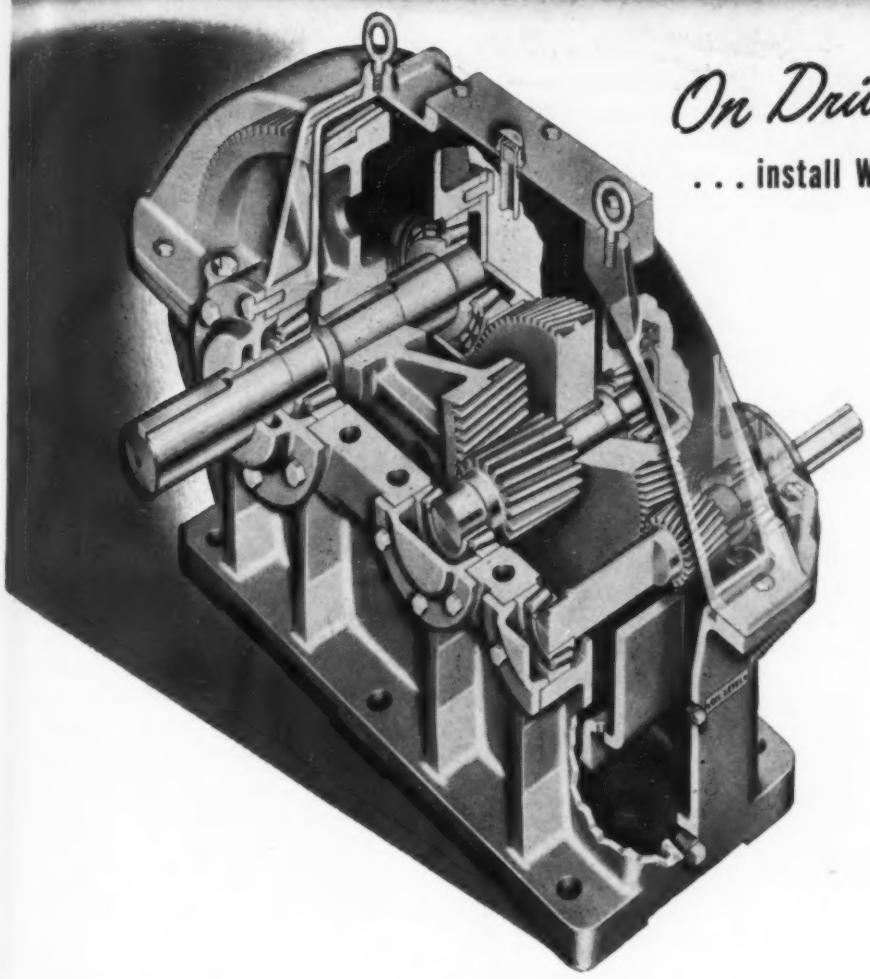
- ***BPT Heat-Treating*** of all gearing and shafts. Gears have greater load capacity, higher resistance to wear and shock.
- ***Single Helical Gears***—cut by Hobbing Process for maximum accuracy... assure quiet operation and long life.
- ***Detailed Inspection Methods*** — Station-to-station check on parts during manufacture, and running test on each assembled unit before shipment.

On new drives, or modernization of old ones, consult Westinghouse. Complete engineering facilities... complete service after the installation... plus the benefits of undivided responsibility, that's what you get when you buy a drive from Westinghouse. Call your Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

J-07232

# Westinghouse

There is a Westinghouse speed reduction unit for most application needs



*On Drives up to 1000 hp*

**. . . install Westinghouse Speed Reducers**

Benefit these 6 ways:

1. Minimum maintenance
2. Higher drive efficiencies
3. Maximum reliability
4. Improved appearance
5. Increased safety
6. Designed and applied to A.G.M.A. Standards

Two types of standard Westinghouse Speed Reducers—offer speed ratios from 2.82 to 70.5. The type SH single-reduction unit is available with 13 standard ratios, from 2.82 to 9.5. The type DH double-reduction unit is available with 15 standard ratios, from 11.8 to 70.5. Special units are available for unusual conditions.

*For Drives 1 to 75 hp*

**. . . install Westinghouse Gearmotors**

Here are 6 good reasons:

1—HIGH EFFICIENCY
2—MINIMUM NUMBER OF PARTS
3—USE ALL STANDARD TYPE WESTINGHOUSE MOTORS
4—EASY ACCESSIBILITY
5—MOTOR AND GEARS BUILT BY ONE MANUFACTURER
6—DESIGNED AND APPLIED TO A.G.M.A. STANDARDS

A complete line of gearmotors is available for a wide range of applications.

A typical double-reduction type gearmotor.

*Speed Reducers*

# New Literature

▲ There are probably not many subjects more complicated than that of metal cutting. The main elements involved in the subject are the work being cut, the tool doing the cutting, and the cutting fluid. In spite of the tremendous amount of money, energy, and thought expended in studying the subject of metal cutting, it still can not be called a science, but is only now becoming an advanced art. Many scientific papers and treatises on the subject have brought to light certain principles which by themselves respond to scientific analysis.

"A Bibliography on Cutting of Metals" was prepared by Orlan W. Boston, professor of metal processing, at the University of Michigan, and published in 1945 by the American Society of Mechanical Engineers. The bibliography brings up to date the information which Prof. Boston published as a A. S. M. E. Research Bulletin in 1930, and one published by him in 1935. The new publication is sponsored by the A. S. M. E. Special Research Committee on Metal Cutting Data and Bibliography.

▲ Ingersoll-Rand has just issued "An Audit of the Carbon, Oxygen and Hydrogen in an Iron Blast Furnace" by J. S. Fulton. The publication analyzes the qualities of top gas, and studies the mathematical balance between the weight of C and $O_2$ probably received by the furnace and that reported in the top gas.

▲ Advantages of the centralized lubricating system when installing machine equipment for postwar operations are pointed out in an illustrated four-page folder, "When you Reconvert," issued by The Farval Corporation, Cleveland, Ohio. Basic facts are set forth in a compact summary showing how the Farval system operates, with statements of specific results attained through its use.

The complete range of Farval systems, including both manual and automatic types for a wide variety of industrial equipment, are illustrated. A copy of the folder may be obtained by addressing The Farval Corporation, 3249 East 80th Street, Cleveland 4, Ohio.

▲ Featuring the uses of lubricants in lubricated plug valves, Merco Nordstrom Valve Company has just released a new and completely reedited manual.

It gives complete instructions in application of valve lubricants and lists 40 types in stick and bulk form including a silicone type. More than 100 specific valve services are included, with corresponding lubricant recommendations, for various conditions of line fluid, temperature and pressure.

A copy may be obtained by any user of Nordstrom Valves. The manual is No. V-105, Rev. 6. Address Merco Nordstrom Valve Company, 400 Lexington Avenue, Pittsburgh 8, Pennsylvania.

▲ An up-to-date price list and catalog of Airco gas welding and cutting supplies and accessories has recently been published by Air Reduction, 60 East 42nd Street, New York 17, New York. This 16-page booklet contains illustrations, descriptions, engineering data, and current prices.

Types of equipment covered include: welding rods, brazing and welding flux, hose, brazing alloys, goggles and spectacles, gloves for gas welding and cutting, and sparklighters and tips. Also listed are: carbon rods and plates, hardfacing rods, cobalt borium inserts, pea borium, and other items.

Information concerning properties and uses accompanies each article listed. Wherever possible, precise quantitative data are supplied. Numerous photographs and sketches supplement the text.

Ordering is facilitated by the listing of sizes and stock numbers in easily-read columns. Complete directions for ordering are included.

The booklet also lists the addresses of Airco offices throughout the country from which these gas welding and cutting supplies can be supplied promptly.

Copies of this price list may be obtained by writing for Catalog No. 40 to Air Reduction, 60 East 42nd Street, New York 17, New York, or to the nearest Airco office.

▲ The Metallizing Company of America, pioneer manufacturers of metal spraying equipment, have recently published a 4-page circular describing the new Mogul Model F Metallizing Gun.

This interesting illustrated circular gives complete information on construction features, including exploded view of gun parts, spraying speeds and gas consumption. The circular also shows the equipment necessary for a complete metallizing setup together with prices.

Those interested in high-speed metal spraying for production and maintenance applications or corrosion protection should write to the Metallizing Company of America, 1330 W. Congress Street, Chicago 7, Illinois, for Circular No. F-1-A.

▲ The new "General Box" issue is now available to the public free of charge. This informative booklet, published by the General Box Company of Chicago, provides up-to-date details on containers and is packed with colorful illustrations. Of special note in this issue is an article on the Army Quartermaster Supply Depot in Jeffersonville, Indiana. This story is told with emphasis upon the part containers have played in supplying equipment to the Armed Forces of the United States.

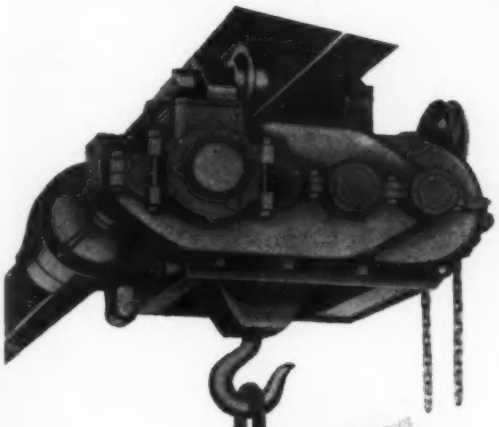
Also, the new "General Box" gives additional information about the various types of containers now being manufactured, along with new and interesting box design for different products.

Further details about containers designed by General Box Company are also included to provide product protection under all conditions, as well as being made with an eye to maximum strength with minimum weight. You may obtain your copy of this free booklet by writing General Box Company, Chicago, Illinois. There is no obligation on your part.

▲ Walker-Jimieson, Inc., Radio and Electronic Distributor at 311 South Western Avenue in Chicago, has published a series of brochures listing various types of industrial equipment. The brochures are designed to acquaint industrials with various types of equipment available for improving production, inspection and research facilities. Among the titles are Voltage Supply Equipment, Lighting Equipment, Shop Tools and Equipment, Sound Equipment, Electrical Maintenance Equipment and Test and Inspection Equipment. These brochures are offered by this firm free of charge to engineers and purchasing agents.

# High Grade Heavy Duty Hoists for heavy duty service...

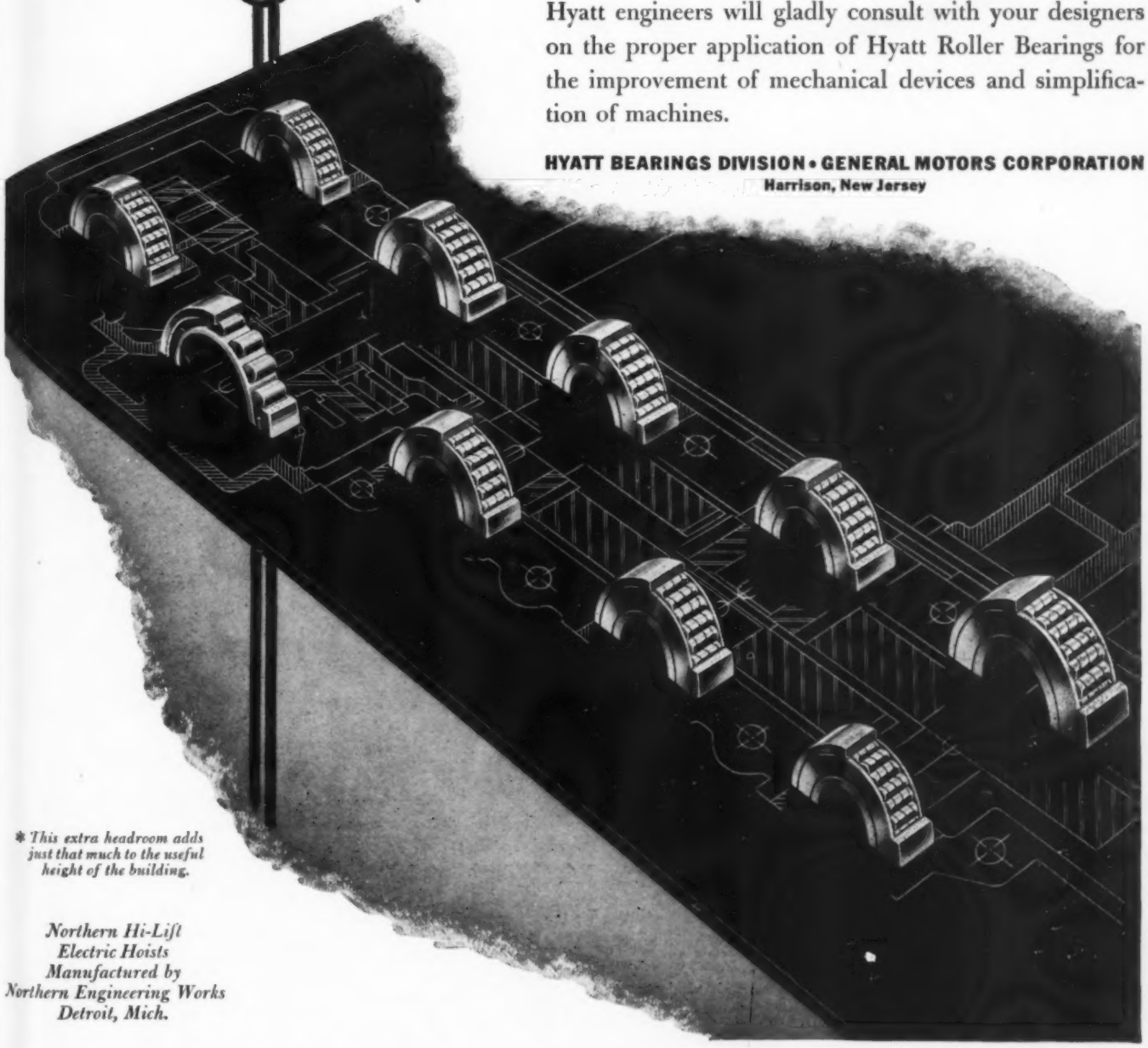
**BEARINGS: HYATT**



Distinguishing advantages of Northern Hi-Lift Hoists are extreme high hook lift adding one to two feet to the effective working height,* perfect balance and unusual accessibility of all parts for inspection or maintenance. For the heavy work these hoists do, great structural strength is needed. Their shafts are kept in alignment and free running with high-precision, frictionless Hyatt Roller Bearings.

Hyatt engineers will gladly consult with your designers on the proper application of Hyatt Roller Bearings for the improvement of mechanical devices and simplification of machines.

**HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION**
Harrison, New Jersey



* *This extra headroom adds just that much to the useful height of the building.*

*Northern Hi-Lift Electric Hoists Manufactured by Northern Engineering Works Detroit, Mich.*

BUILT BY MORGAN *Engineering*

**MORGAN 300-TON, 65′0″ SPAN POURING CRANE**

Illustrated is one of two Morgan 300-Ton, 65′0″ Span, four-girder Ladle Cranes with 50/15-ton auxiliary trolley in a Mid-Western Electric Furnace Steel Plant.

Efficient and dependable — such huge cranes play an important part in stepping-up steel production to meet present-day demands.

Additional Morgan equipment in this plant includes:
Three 150-Ton, 65′0″ Span Pouring Cranes.
Two 150-Ton, 80′3″ Span Hot Metal Charging Cranes.
Two 200-Ton, 63′0″ Span Universal Type Ingot Strippers.

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ALLIANCE, OHIO. 1429 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES SOAKING PIT COVERS • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES SPECIAL MACHINERY FOR STEEL MILLS

# Personnel News

**Clark W. King** has been appointed executive assistant to **Hiland G. Batcheller,** president of the Allegheny Ludlum Steel Corporation, Brackenridge, Pennsylvania.

Mr. King comes to Allegheny Ludlum after more than four years' service with the Steel Division of the War Production Board, Washington, where he served continuously as special assistant to each of the seven successive directors of that division. While in Washington, Mr. King was on detached service with the Bethlehem Steel Company, Bethlehem, Pennsylvania.

From 1928 to 1935, Mr. King was with the American Steel & Wire Company's New York sales office, having, however, been granted leave from that company from 1933 to 1935, to serve under the Board of Directors of the American Iron & Steel Institute, in the administration of the NRA steel code. He then joined the commercial research and industrial development division of the Bethlehem Steel Company, and in 1941 took up his duties with the War Production Board.

**Frank E. Walling,** acting manager of the Lewis Foundry & Machine Division of Blaw-Knox Company, has been promoted to president and general manager of the division.

Mr. Walling has been associated with the Lewis Foundry & Machine Division since 1941, first as assistant to the manager, then as vice president in charge of operations, and lately as acting manager. Since his graduation from Lehigh University and before joining Blaw-Knox, he had been associated with the Lukens Steel Company in Coatesville, Pennsylvania, and the Carnegie-Illinois Steel Corporation in Duquesne, Pennsylvania.

**Walter R. Breeler** has succeeded **Charles Spittall,** retired, as general manager of the Allegheny Ludlum Steel Corporation's Dunkirk, New York plant. Mr. Breeler formerly was assistant general manager, and has been with the Dunkirk plant since 1926.

The holder of many United States and foreign patents on steels and steel processes, Mr. Breeler is a member of the American Iron and Steel Institute, and served on its wartime technical committees for tool steel, shells, machine gun and bullet core steel. During the war, he worked with the Office of Scientific Research and Development, of the National Defense Research Committee, in developing ordnance materiel.

A native of Cleveland, Ohio, he was graduated in chemical engineering from the Case School of Applied Science in 1921, having a degree in metallurgical engineering conferred upon him by Case in 1929.

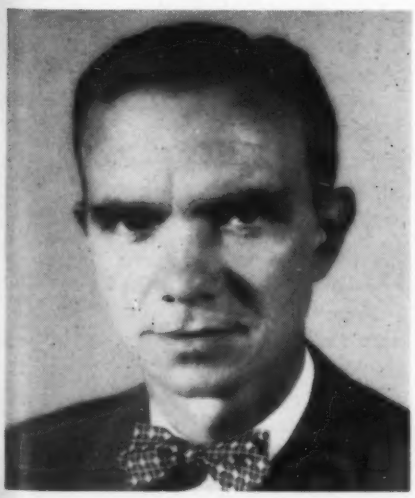
**James K. Lamoree** has been appointed assistant chief engineer of the Pittsburgh district, Carnegie-Illinois Steel Corporation. Mr. Lamoree is a native of Pittsburgh and a graduate of Carnegie Institute of Technology where he received his degree in mechanical engineering in 1914. He started his service with United States Steel Corporation in October 1912 at the Shenango Works of American Sheet and Tin Plate Company. In September of 1936 he was transferred to Carnegie-Illinois Steel Corporation's South Works as development and estimating engineer, and in February 1945 he came to Pittsburgh general offices as senior staff engineer, the post he held until his present appointment.

Mr. Lamoree succeeds **Fred H. Johnson** who has been transferred to the Chicago district.

**Rowland B. Drescher** has been appointed manager of Pittsburgh district for the Republic Flow Meters Company, with offices in the Investment Building. He succeeds **Carl E. Pritchett** who died on April 12th after managing that district for twenty-three years.

Mr. Drescher is a mechanical engineering graduate of Renssalaer Polytechnic Institute and had considerable engineering and power plant operating experience before joining Republic. His promotion from Republic's contract engineering department comes after eight years of engineering a great variety of applications of Republic

C. W. KING



W. R. BREELER

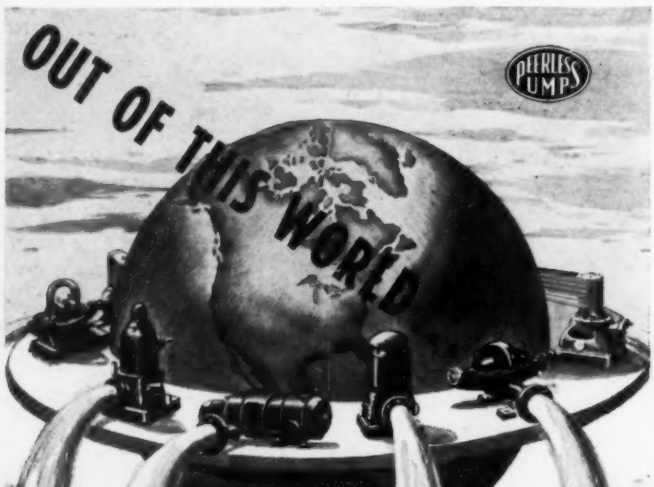
R. B. DRESCHER

Remember IMO forget TROUBLE

The IMO PUMP has only three moving parts and no valves, timing gears, cams, or delicate adjustments to get out of order. It can be depended upon for hydraulic service, governor service, lubrication service and other applications in which continuity of operation is vital.

*For further information write for Catalog I-126-1*

IMO PUMP DIVISION OF THE DE LAVAL STEAM TURBINE CO. TRENTON 2, NEW JERSEY

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5 to 220,000 gallons per minute

*Distributors in all principal cities*

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FACTORIES LOS ANGELES 31, CALIFORNIA 301 West Avenue Twenty-six QUINCY, ILL. • CANTON 6, OHIO

combustion control, regulators, reducing valves, desuperheaters and instruments.

FRANS WETHLY

**Frans Wethly** has been appointed a vice president of the Wilputte Coke Oven Corporation, New York, New York.

Mr. Wethly, who is 44 years of age, has been identified with gas plant and coke oven design, engineering and construction since he was 19 years of age. His career began with builders of gas plants in his native Holland. At the age of 22 he joined the Dutch affiliate of Dr. C. Otto & Company. He was associated with the Otto interests in various capacities for almost 20 years, supervising construction and operation of coke oven and related types of plants in Great Britain, Belgium, Holland, Germany, France and India. In 1939, shortly after the Otto Construction Company was formed in the United States, he came to America and was active in the direction of that company which he left in 1942, and later joined the Wilputte Coke Oven Corporation.

**H. J. French** has resigned as assistant Director for raw materials and facilities of the Steel Division, War Production Board, at Washington, D. C., and has resumed his duties as assistant manager of the development and research division of The International Nickel Company, Inc., at New York.

Mr. French joined the Iron and Steel Branch of the War Production Board late in February 1942 when he organized and became chief of the metallurgical section. With the formation of the Steel Division he became chief of the metallurgical branch and in March 1944 was appointed assistant director. He leaves Washington after forty-two months' service with the Board.

**W. E. Dueringer** has been named assistant sales manager and **H. E. Weaver** as proposition department manager for Bailey Meter Company, Cleveland, Ohio.

Both Mr. Dueringer, who is a graduate of the University of Illinois and Mr. Weaver, who is a graduate of Johns Hopkins University, have been associated with Bailey Meter Company for over 25 years in various engineering and sales capacities. During this time they have solved successfully many difficult problems in the

application of metering and control equipment. Their combined experience covers a wide range of steam power plants and process industries.

**Peer Nielsen** has been made vice president and general superintendent in direct charge of operations at the Kaiser steel plant at Fontana, California. Mr. Nielsen is a graduate of Lehigh University, and has for twenty-one years held positions of responsibility in subsidiaries of United States Steel Corporation, including service as general superintendent of the National Tube works at Lorain, Ohio, and at Elwood, Indiana. In October, 1943, Mr. Nielsen was appointed general superintendent of the Geneva steel plant, which was built and operated for the Defense Plant Corporation by the Geneva Steel Company, a subsidiary of United States Steel Corporation.

**Frank Backman,** who served as general superintendent during the original construction of the Kaiser steel plant, remains as general superintendent in charge of new construction. During the past two years, Mr. Backman has directed wartime operations at Fontana which have been distinguished by production in excess of the plant's rated capacity, and by the use of Western ores and coal not hitherto employed in steel production.

R. E. O'BRIEN

**Robert E. O'Brien** has joined the sales organization of the Heppenstall Company, Pittsburgh, Pennsylvania. A native of Indiana, Mr. O'Brien attended law school at Notre Dame University. Since 1930 he has been employed in operational capacities for Bethlehem Steel Company and Jones and Laughlin Steel Corporation.

**William C. Van Cleaf** has been appointed director for industrial relations for the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin. Prior to his appointment, Mr. Van Cleaf served as assistant to **Lee H. Hill,** former head of industrial relations who resigned to go with the McGraw-Hill Publishing Company.

Mr. Van Cleaf entered Allis-Chalmers employment in 1912 as an electrical apprentice. Following completion of his indenture, he worked in the service and erection department. Later, he was promoted to assistant foreman on the electrical test floor. Appointed

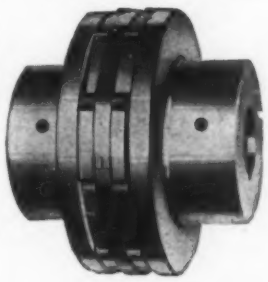

*What do Iron and Steel Engineers demand in a*

**FLEXIBLE SHAFT COUPLING?**

- ***Positive*** correction for misalignment.
- ***Dependable*** takeup of shock, vibration, blacklash, endwise displacement, etc.
- ***Instant*** adjustment to emergencies affecting full power flow.
- ***Inspection*** facilitated by cushions always in sight.
- ***Interchangeability*** — No shutdowns for changing.
- ***Extreme*** quiet.

**L-R**

**FLEXIBLE COUPLINGS**



L-R Type "W"
2 to 2500 h.p.
Pat. & Pats. Pend.

L-R Couplings embody all the above factors, and many others. The L-R resilient alignment principal frees couplings of power-destroying *internal friction.* Resilient load cushions of various materials *each adapted to its particular service* — indoors or outdoors — meet all temperature, humidity, and insulation requirements. L-R Couplings never need lubrication.

Have L-R Quick-Finding Selector Charts in your files.

Charts come free with complete catalog with full engineering data on couplings from 1/6 to 2500 h.p. Wire or write

**LOVEJOY FLEXIBLE COUPLING CO.**

5016 West Lake Street, Chicago 44, Illinois
Pittsburgh Office: Edward J. Boyle Co., 508 Grant Street

general supervisor of apprentice training, he was soon made company employment manager, and with reorganization of the industrial relations division, was made assistant to Mr. Hill.

**K. B. Coates,** assistant treasurer of the Great Lakes Steel Corporation, has been elected president of the Detroit Control of the Controllers Institute of America. Two other steel company executives were accorded similar honors at the annual meetings of their local controllers' organizations — **George H. Maslen,** comptroller of the American Chain & Cable Company, Bridgeport, and **John Pugsley,** controller of the Tennessee Coal, Iron & Railroad Company, Birmingham, Alabama.

**Dr. Harry G. Mitchell** has rejoined the Speer Carbon Company and their affiliate, the International Graphite & Electrode Corporation after serving as carbon products consultant for the War Production Board since August, 1942. He has been appointed advertising manager for both organizations and will be at the home office in St. Marys, Pennsylvania.

**Harry A. Winne,** vice president in charge of engineering for the General Electric Company's apparatus department, has been appointed vice president in charge of engineering policy for the entire company. **Ernest E. Johnson,** assistant engineer of the aeronautics and marine engineering division, has been named to succeed Mr. Winne.

In assuming his new duties, Mr. Winne becomes a member of the president's staff and will coordinate the engineering, scientific, and research projects of all departments and all laboratories of the company.

Mr. Winne, a native of Cherry Valley, New York, joined General Electric as a student engineer in the testing department upon his graduation from Syracuse University in 1910. The following year, he became head of the large motor, generator, and synchronous converter test, and subsequently became assistant general night foreman of the testing department.

In 1916, Mr. Winne was promoted to the power and mining engineering department, now known as the industrial divisions, and six years later, was assigned to the steel mill section of the industrial engineering department, becoming head of that section in 1930.

In 1937, he was named assistant to the engineering vice president, and in 1941 was elected vice president in charge of apparatus design engineering.

Mr. Johnson, born in Ironwood, Michigan, joined the General Electric testing department after being graduated from Washington State College in 1922. He was assigned to the engineering general department in 1924, where he was engaged in personnel and engineering activities.

In 1931, Mr. Johnson was named assistant to the executive engineer of the General Electric Research Laboratory, and later became engineer of the generator voltage regulator department. He subsequently became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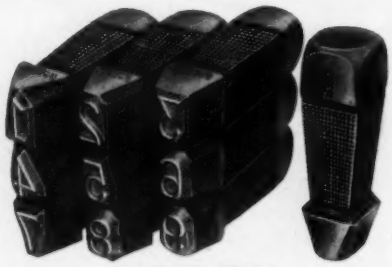
(REG. TRADE MARK)
**LETTERS and FIGURES**



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No mushroom . . . no spall . . . perfect balance. Knurled sides assure *positive* grip to give clearer, deeper impressions — also lessen severity of extra heavy stamping. Characters available from 1/16" to 1".

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On the widest range of TOUGH Rolling Mill Service, GATKE Fabric Bearings are eliminating delays and avoiding costly machine shop service. Precision moulded in all shapes and sizes for installation without machining. Made of many different material combinations to meet various service requirements in types for water lubrication, oil- or grease-lubrication and some unlubricated applications. Write for particulars.

Gatke MOULDED FABRIC Bearings
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engineer of the aeronautics division, aeronautics and marine engineering department. For the past few years he has been assistant engineer of the aeronautics and marine engineering division.

W. T. KELLY, JR.

**William T. Kelly, Jr.** has been elected president of the Kellogg Division of American Brake Shoe Company. Mr. Kelly has been executive vice president of Kellogg since December, 1944.

Mr. Kelly joined American Brake Shoe by way of National Bearing Metals Corporation, a subsidiary. He was transferred to Brake Shoe's purchasing department in New York in 1929 and became general purchasing agent in 1940. He continues to hold this position.

**J. F. Weller,** formerly president of the Kellogg Division, will now devote his full time, as director of automotive sales, to post-war development programs for Kellogg and American Brakeblok Divisions.

**Charles F. Greene** has been made Atlanta representative and **R. D. Birge,** Detroit representative of the storage battery division of Philco Corporation. Mr. Greene attended the University of Florida and was formerly connected with A. K. Sutton, Inc., Philco distributors in Charlotte, North Carolina.

Mr. Birge was graduated from Purdue University in the electrical engineering course in 1938. He was associated with the Louis Allis Company as field engineer in Detroit for three years and more recently in Philadelphia for one year.

**S. B. Heppenstall, Jr.,** is now president and owner of Pittsburgh Carbon Brush Company, Pittsburgh, Pennsylvania. Mr. Heppenstall was formerly a vice president of the Heppenstall Company and, more recently, of the H. K. Porter Company.

**R. H. Hausen,** former president of Pittsburgh Carbon Brush Company is now vice president.

**L. E. Feisner** has been placed in charge of shear blade manufacture and fabrication, as well as of the machine shop and tool bit room, for Braeburn Alloy Steel Corporation, Braeburn, Pennsylvania. Mr. Feisner was formerly in operational positions with various large steel companies and spent some time in Russia on construction work.


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FROM DOLLARS TO PENNIES
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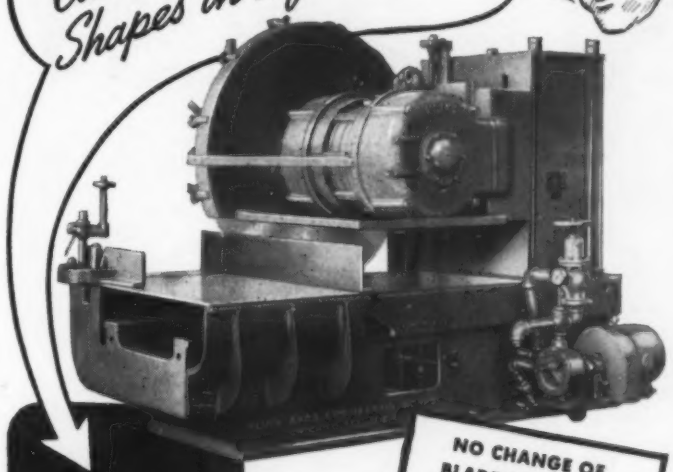
KLING Friction Saws Cut All these Bars and Shapes in a few Seconds



24" 100# I-BEAM 28 SECONDS
15" 55# CHANNEL 15 SECONDS
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9 SECONDS 100# A.R.A. RAIL
5 SECONDS 6½"x6½"x19.8# TEE
11 SECONDS 8"x8"x¾" ANGLE
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15 SECONDS 4" ROUND
11 SECONDS 6" O.D. TUBE ½" WALL

NO CHANGE OF BLADE OR SET-UP NECESSARY

INCREASES PRODUCTION...
CUTS ALL CLASSES OF STEEL - QUICKLY AND ECONOMICALLY

The versatile ability of the Kling Friction Saw to cut varied structural shapes in any sequence, without change of blade or set-up, permits one machine to handle various types of work which, otherwise, would require several slow speed saws to handle.

The installation of a Kling Friction Saw will quickly convince you of its superiority and advantages over the old type of saw. Furthermore, you will cut your cutting costs — savings will be effected in time and labor because of speed and efficiency of the Kling Saw.

GET COMPLETE INFORMATION

CONSULT KLING ENGINEERS REGARDING YOUR CUTTING PROBLEMS. WRITE FOR BULLETIN No. 9200 GIVING VALUABLE INFORMATION. SENT WITHOUT COST OR OBLIGATION.

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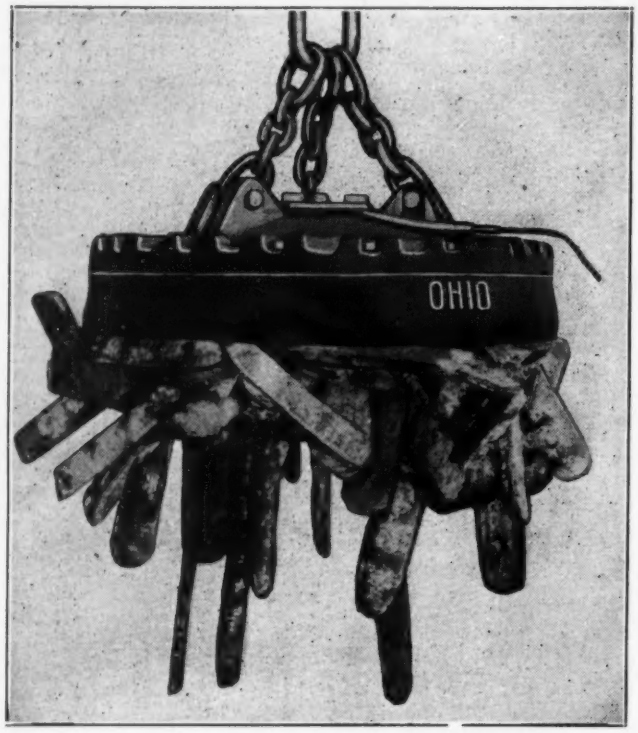
# IF YOU HANDLE IRON OR STEEL

## YOU NEED AN

# OHIO MAGNET




**WHY? Because a magnet will do the work at 1/10 the cost of doing it by any other means.**

**A 45" magnet will lift, transport and deposit 1600 lb. of heavy scrap every one-half minute or less.**

**How many men would you need to do that job that fast?**

**The Ohio Electric Mfg. Co.**

**5907 Maurice Avenue CLEVELAND 4, OHIO**


**L. H. Gegenheimer,** after a four-year leave of absence for war duties in Washington, is back with The Timken Roller Bearing Company, Canton, Ohio, in his former capacity as sales engineer in the industrial division.

Mr. Gegenheimer, a native of Vermilion, Ohio, was first loaned by The Timken Company to the British Ministry of Supply, where he was supply officer until December, 1943, after which he became a dollar-a-year man with the War Production Board.

## *Obituaries*

**George W. Lentz,** a well known consulting and development engineer of steel mill equipment, died September 19th at the age of 71 at his home in Canton, Ohio. His death followed an illness of six weeks due to a heart malady.

Mr. Lentz was born in Indianapolis, Indiana. His first invention was a wood-embossing machine which has been used in all parts of the United States. He then turned to the steel industry and became superintendent of the Northwestern Metal Lathe Company at Jeannette, Pennsylvania. He was next associated for seven years with the Berger Division of the Republic Steel Corporation in the metal lathe department. For the past seventeen years, Mr. Lentz was associated with the Bonnot Company, and was the originator and patentee of the Bonnot-Lentz Billeteer.

**James S. Fulton,** special representative for Ingersoll-Rand Company, died September 23. Born in Pittsburgh, Pennsylvania, Mr. Fulton graduated from University of Michigan, and had been associated with Ingersoll-Rand for the past 30 years. He specialized particularly in the blast furnace field and was the author of numerous technical papers on blast furnace topics.

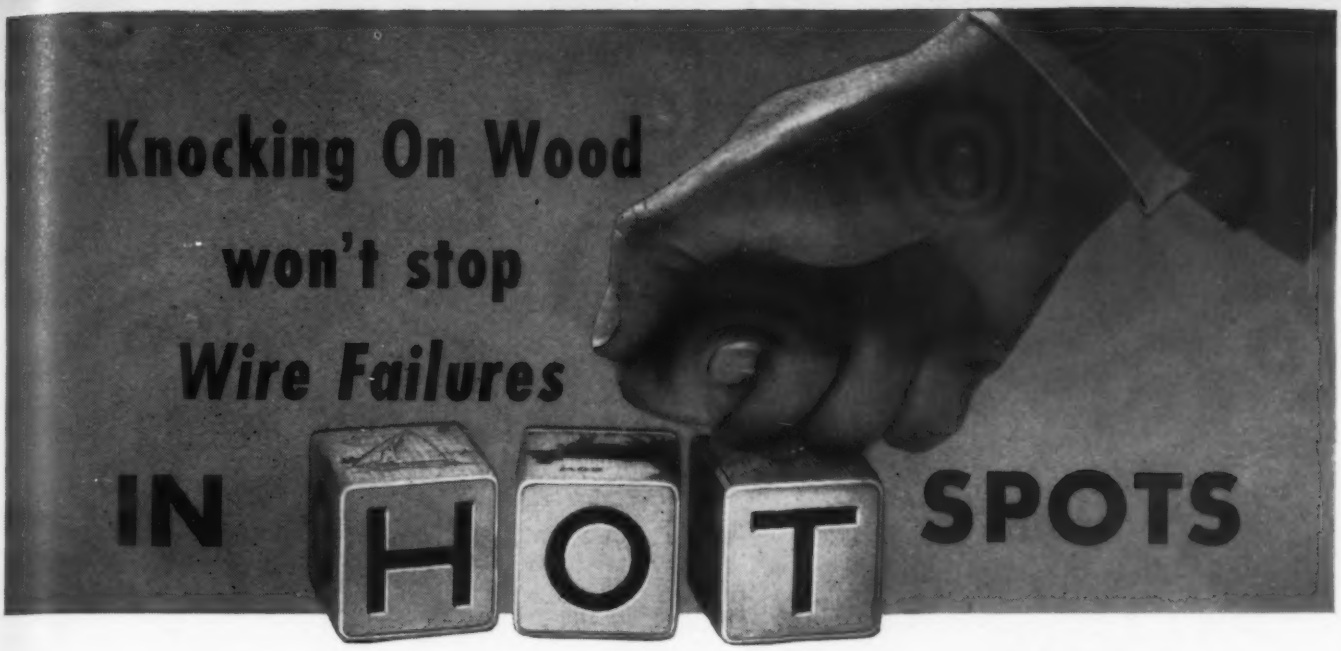
**Joseph W. Koss,** general foreman in the cold rolled finishing department at Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania, died recently as the result of injuries sustained at work.

Mr. Koss, who had been with Jones and Laughlin seven years, formerly was an assistant superintendent for Wheeling Steel Corporation at Yorkville, Ohio.

**Morris S. Earl,** Chicago district manager of the Electric Service Manufacturing Company died suddenly September 3. Mr. Earl had been connected with this company since it was formed in 1906 and prior to that time he was employed by Porter & Berg Company.

**Ralph Ware,** for the past 38 years secretary and treasurer of Ware Brothers, died September 16.

Mr. Ware was born in Chicago in 1877, and graduated from Hyde Park High School and from Cornell University. He became a junior partner of the Elisha C. Ware Real Estate Company in Chicago, and in 1907 was made secretary and treasurer of Ware Brothers.

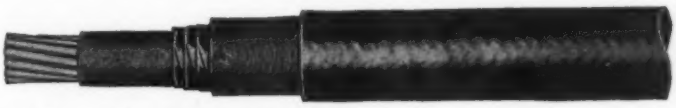



Continuous operation, copper-heating overloads, high ambient temperatures, oil, grease and corrosive fumes have been rough on emergency power, control and lighting wiring that wasn't built to stand up long under such conditions . . . so don't trust to luck and be sorry later.

Check up right now on war-worn circuits that run too close to steam lines, furnaces, forging presses, annealers, kilns, soaking pits . . . or anywhere that heat and other severe conditions may cause trouble . . . and rewire with Rockbestos A.V.C. *permanently insulated* wires and cables. They save money by practically eliminating maintenance because they are built to take 230° F. without baking brittle, cracking, flowing or de-centering . . . and won't rot or bloom from contact with oil, grease or corrosive fumes.

For detailed information on Rockbestos-designed National Electrical Code types in our line of 125 different standard constructions, write to the nearest branch office or:

**ROCKBESTOS PRODUCTS CORPORATION, 105 NICOLL ST., NEW HAVEN 4, CONN.**



1 2 3 4 5

**ROCKBESTOS A.V.C. 600 VOLT POWER CABLE (National Electrical Code, Type AVA)**

The cable above and similarly insulated Motor Lead Cable have a maximum operating temperature rating of 110° C. (230° F.) and this permanently insulated construction:

1. The conductor is perfectly and permanently centered in helically applied insulation.
2. Felted asbestos insulation, impregnated with heat, flame and moisture resisting compounds, withstands conductor-heating overloads and won't dry out, bake brittle, flow or burn.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance, protected from heat and flame by two felted asbestos walls.
4. Outer felted asbestos wall, impregnated with heat, flame, and moisture resistant compounds, serves as an effective barrier against high ambient temperatures and flame.
5. A tough rugged asbestos braid, resistant to heat, flame, moisture, oil, grease and corrosive fumes.

*125 different wires, cables and cords developed for severe operating conditions by Rockbestos.*

**INVEST IN U. S. VICTORY BONDS**

# ROCKBESTOS A.V.C.

## *The Wire with Permanent Insulation*

NEW YORK BUFFALO CLEVELAND CHICAGO PITTSBURGH ST. LOUIS
LOS ANGELES SAN FRANCISCO SEATTLE PORTLAND, ORE.

**ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE**
**(Nat. Elec. Code Type AVA—max. operating temp. 110°C.)**

*Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of impregnated asbestos next to the conductor.*

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard, such as exist around furnaces, ovens, lehrs, soaking pits, boilers, etc., this widely used A.V.C. construction is ideal. Its permanent insulation will not bake brittle, crack, rot, flow or swell.

**ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE**

*In one to 19 conductors with individuals insulated like Power Cable, cotton braid covered, and cabled with an asbestos braid overall. Standard strandings AWG No. 12—19/#25 and No. 9—19/#22. Other strandings on order.*

Designed for use in equipment requiring a multi-conductor control cable capable of withstanding high temperatures, this cable is widely used in the control systems of electric cranes and other equipment used in steel mills. The insulation is unaffected by heat, corrosive fumes, oil or grease and has ample moisture resistance.

★ ★ ★ ★ ★

**ANOTHER NEW ROCKBESTOS FIREWALL CONSTRUCTION!**

War-developed Rockbestos High-Temperature Wire — *with a maximum operating temperature of 400° F.* — designed for jet propelled plane applications and circuits to hot-wing de-icers, fire detectors and extinguishers, and air conditioning and heating units where baking temperatures destroy ordinary insulation. Under continuous operation at rated temperature it retains its original dielectric strength and inherent resistance to heat and flame, and *progressively improves* in its resistance to moisture and abrasion. It is now available for these and other severe applications. Write for complete information and samples.

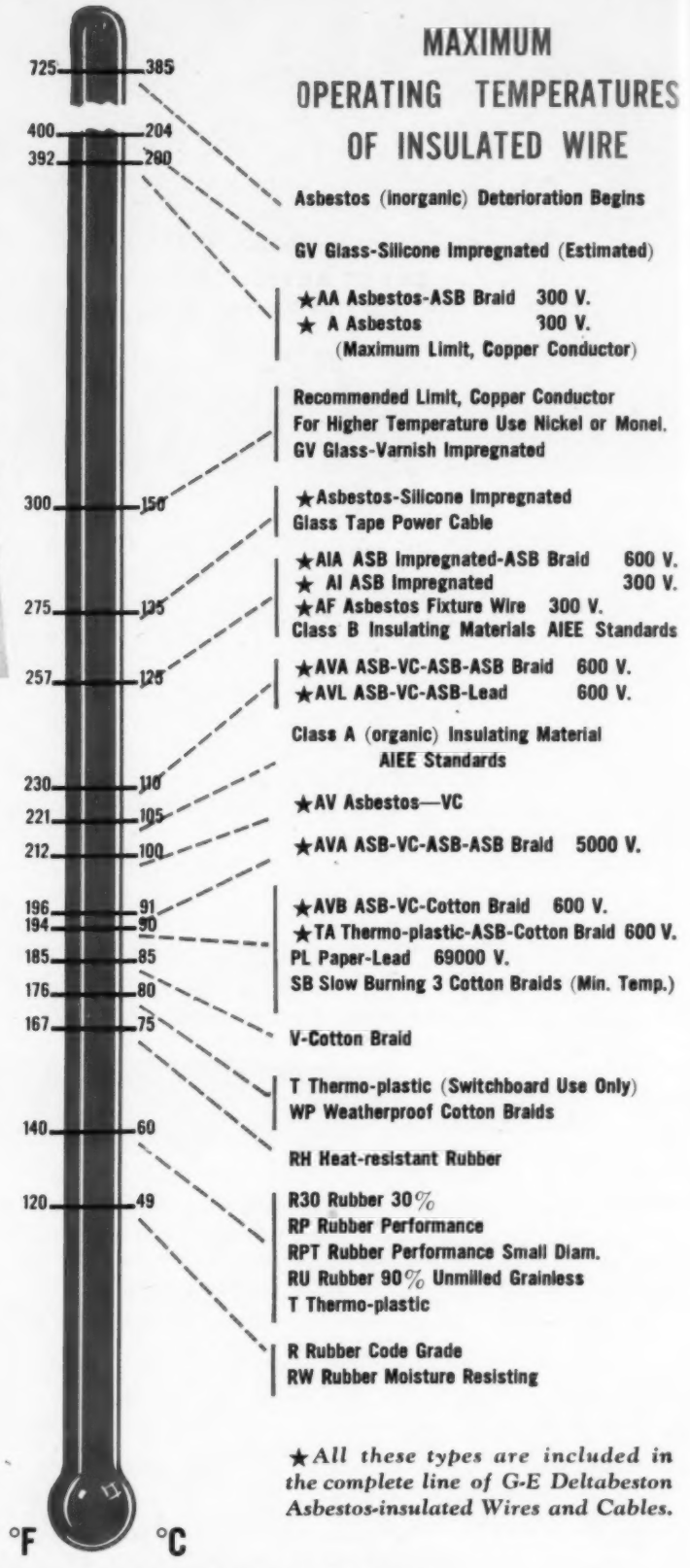
# HERE ARE THE FACTS

## WHY You Should Use DELTABESTON ASBESTOS-INSULATED CABLES

As operating temperatures on the illustrated thermometer increase, you'll note that asbestos-insulated wires are recommended more frequently than other types. That's why you'll want to investigate Deltabeston for wiring installations exposed to constant high temperatures. These heat-resistant cables are designed for control, lighting and power circuits. Regardless of what type of cable you require, where heat is a problem, Deltabeston fits the job.

• • •

The Deltabeston catalog will help you solve your cable problems. For your free copy, write to Section Y1053-31, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn. All Deltabeston Wires and Cables are distributed nationally by Graybar Electric Co., General Electric Supply Corp., and other G-E Merchandise Distributors.



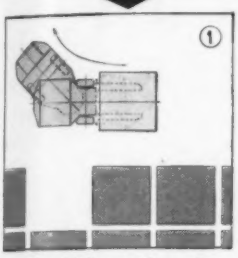

★*All these types are included in the complete line of G-E Deltabeston Asbestos-insulated Wires and Cables.*

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS. "The G-E House Party" Monday through Friday 4:00 P.M. EWT, CBS.

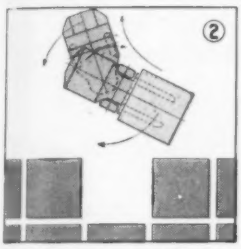
**GENERAL ELECTRIC**

# New Baker ARTICULATED Fork Truck cuts aisle requirements

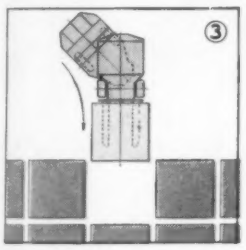
**How the BAKER ARTICULATED FORK TRUCK saves time and space placing loads**



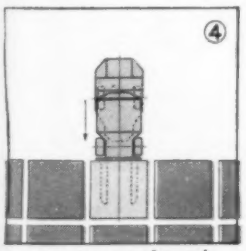
1. The driving section swings away from the load spot.



2. Both sections rotate about 25 degrees around turning center.



3. Truck articulates, lining load perpendicular to aisle.



4. Truck moves forward, spotting load in position.

**Revolutionary new principle** increases available storage area.

***Designed primarily for efficient warehouse operation***

A basically new design* involving a new method of steering by "articulating" the frame, permits swinging the load to line it up in position without lining up the truck itself. Thus this truck requires about two feet less space for placing loads at right angles to aisles. It needs less clearance on turns, and speeds carloading or any other handling operation where loads must be lined up or positioned in congested areas.

*Specific advantages of this truck are:*

1. **Works in narrower aisles.**
2. **Turns in a smaller radius.**
3. **Spots loads quicker and easier.**
4. **Control units are more accessible.**
5. **Simpler Steering design cuts maintenance.**
6. **Permits mechanization of handling where hand trucks were necessary because of space limitations.**

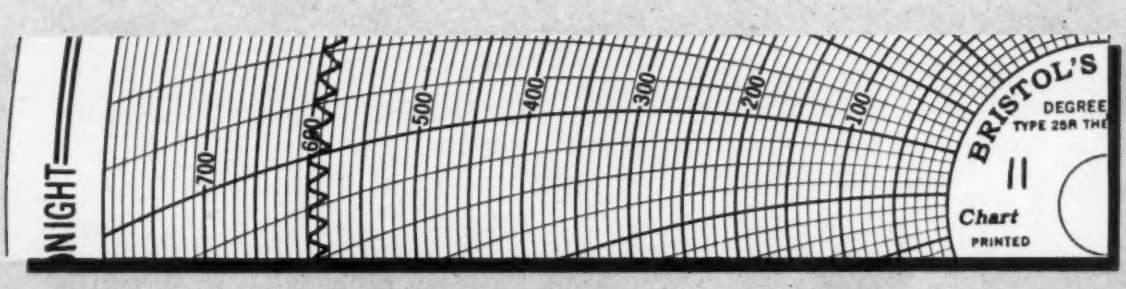
Field tests in both warehouse and production operation have proved the many advantages of this new truck. For complete specifications request Bulletin 1330.

*Licensed under Stevenson Patent No. 2,284,237.

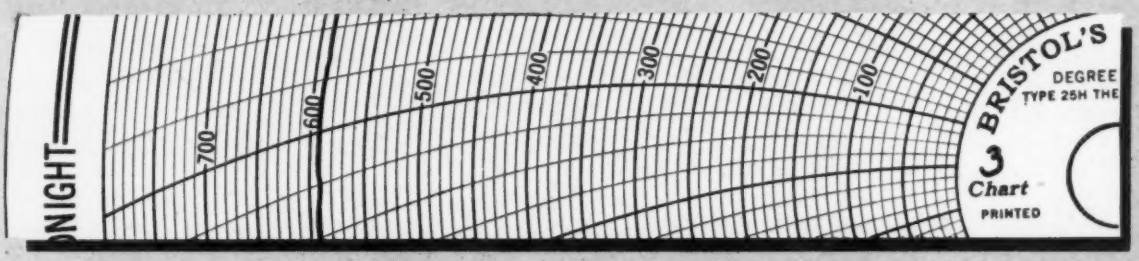
**BAKER INDUSTRIAL TRUCK DIVISION** *of The Baker Raulang Company*
**2166 WEST 25th STREET • CLEVELAND, OHIO**
*In Canada:* Railway and Power Engineering Corporation, Ltd.

**Baker INDUSTRIAL TRUCKS**

# KEEPING INPUT ON THE STRAIGHT-AND-NARROW




Typical On-Off Control




With Bristol Pyromaster Control

## *Temperature in electrically-heated furnaces and ovens unfailingly obeys Bristol's New Input Control*

This new Bristol instrument will provide practically a straight-line record of temperature in electrically-heated ovens, furnaces and salt pots or any electrically-heated apparatus now equipped with on-off control.

In the Bristol Pyromaster Input Controller, the load circuit is opened and closed periodically to furnish the heat input required to maintain the proper temperature As the temperature increases beyond the control point, the contact period increases; when the temperature decreases below the control point, the contact period increases.

Throttling range is adjustable from 2% to 8% of full range A minimum amount of adjustment is required For further information, address THE BRISTOL COMPANY, 123 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ont Bristol's Instrument Co., Ltd., London, N.W 10, England)

**Bristol's Model 431-42 Pyromaster Proportional Current Input Controller. Available for use with thermocouple and also as a radiation pyrometer.**

**BRISTOL** ... *Gives YOU the Most from Heat*

AUTOMATIC RECORDING AND CONTROLLING INSTRUMENTS

# *Yoder* MILLS...
## for High Production of Cold-Roll-Formed Resistance Weld Pipe and Tubing

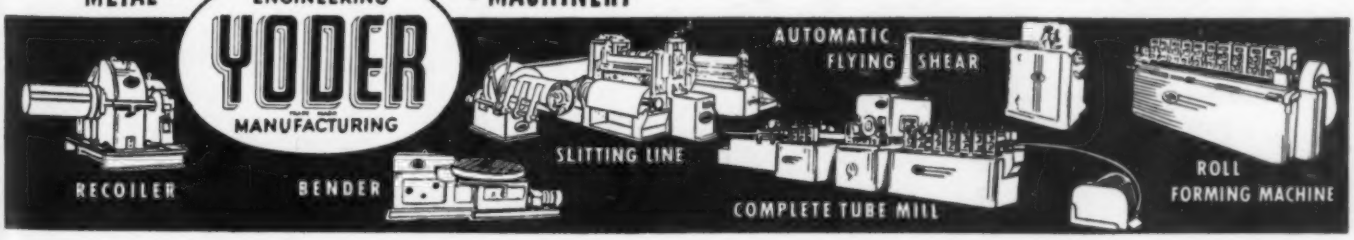
COMPLETE mills for cold-roll-forming and resistance welding continuous tube or pipe from coiled strip stock are made by Yoder in all capacities from ¼″ to 24″ O.D. A complete Yoder installation includes every detail from the stock handling machinery to equipment for finishing, threading and inspecting pipe or tubing in cut lengths. Modern electronic controls bring complete mastery of the entire mill under the fingers of one chief operator, enabling a compact crew to maintain full production.

Yoder mills are efficient for production from most metals and alloys suitable to tube and pipe manufacture. Certain types are particularly noted for their high yield of small pipe from hot rolled skelp, producing the greatest useable tonnage with minimum down time or service problems.

Where required, Yoder tube and pipe mills are available with gas weld equipment, also fully automatic.

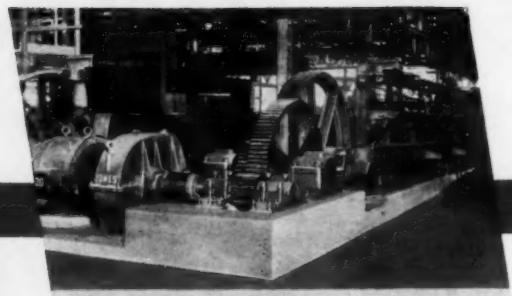
For information on Yoder mills designed to your particular production problem, consult a Yoder engineer in your area.

**THE YODER COMPANY**
5526 WALWORTH AVE., CLEVELAND 2, OHIO

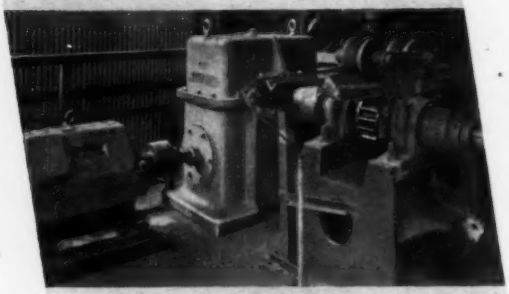


# KEEP GOING

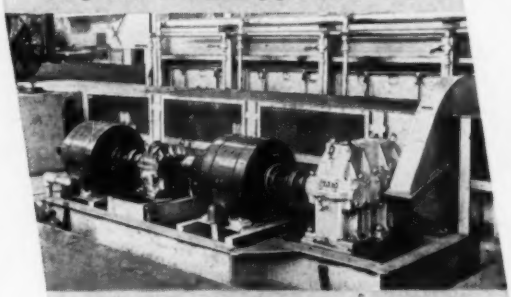
## . . . WITH JONES



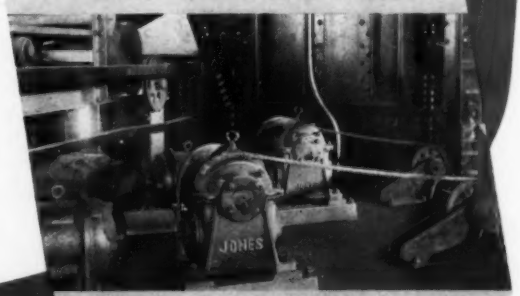
Jones Herringbone Speed Reducer driving steel tube mill draw bench. Gear casings removed to show proportions of spur gear drive to head shaft.



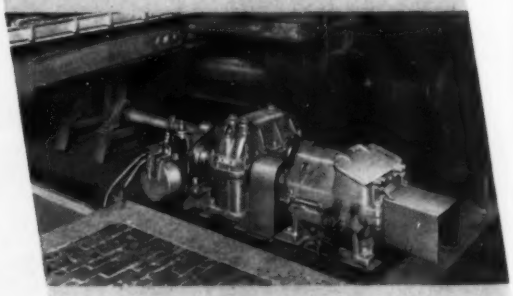
Jones Worm Gear Speed Reducer operating cover of warming pit in steel mill.



Jones Herringbone Reducers operating furnace in steel mill. Drive consists of two motors with single type and double type reducers coupled in series in order to obtain two widely varying speeds.




Two of a battery of 10 Jones Worm Gear Door Hoists for operating open hearth furnace doors.



Jones Herringbone Reducer operating sheet mill tilting drive on feeder table.

• In every phase of the steel business today, whether it is production or fabrication, the cry is "keep going".

The Jones organization, too, is busy manufacturing the various types of speed reducers and other transmission products that are so essential for drives in every type of plant — drives that are so necessary in maintaining peak production.

We picture here some typical Jones drives that have seen years of service in the steel industry. They have been called upon to take a lot of punishment and they will stand the gaff for a good many years to come.

**W. A. JONES FOUNDRY & MACHINE COMPANY**
**4431 Roosevelt Road, Chicago 24, Illinois**

# Jones

**HERRINGBONE — WORM — SPUR — GEAR SPEED REDUCERS • PULLEYS • GEARS • V-BELT SHEAVES • ANTI-FRICTION PILLOW BLOCKS • FRICTION CLUTCHES • FLEXIBLE COUPLINGS**

# FOR 4 lbs. IN A SINGLE STAGE

● One of the really new air moving units on the market, the Buffalo "CC", Centrifugal Compressor, has wide industrial applications. Developed by Buffalo to meet the need for a single stage high pressure blower, the "CC" has amazing performance ability. Since both rotors and housings are "tailor-made" to fit the job — you can get just the amount of air you need at the pressure required. And because, with the aid of the Buffalo Vacuum Test Pit, our engineers have checked all rotors for safe operation, you get a blower which is certain to perform according to specification. If you are interested in details, send for Bulletin 000.

## BUFFALO FORGE COMPANY

173 Mortimer St. BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

## TYPE CC CENTRIFUGAL COMPRESSORS

# NEW DE LAVAL FAN COOLED WORM GEAR

## Lifts ceiling on capacity ratings!

**Heretofore the capacity of non-cooled worm gears has been limited, not by the strength of materials, but by the ability of the casing to liberate heat. With fan-cooling, the capacity is approximately doubled at speeds at 1750 r. p. m. Higher ratings, in turn, permit the use of smaller, lighter, and less expensive units without sacrifice of durability or reliability. • A fan mounted directly upon the high speed shaft draws air at high velocity around and under the ribbed inner wall of the oil reservoir. The ribs increase the heat dissipating surface, while the outer housing serves to confine and direct the air stream, thus cooling the unit most efficiently. • Stock models will soon be available. Ask to have your name placed on our mailing list for literature.**

1151

TURBINES • HELICAL GEARS and WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

WORM GEAR DIVISION
**DE LAVAL**
STEAM TURBINE COMPANY • TRENTON 2, NEW JERSEY

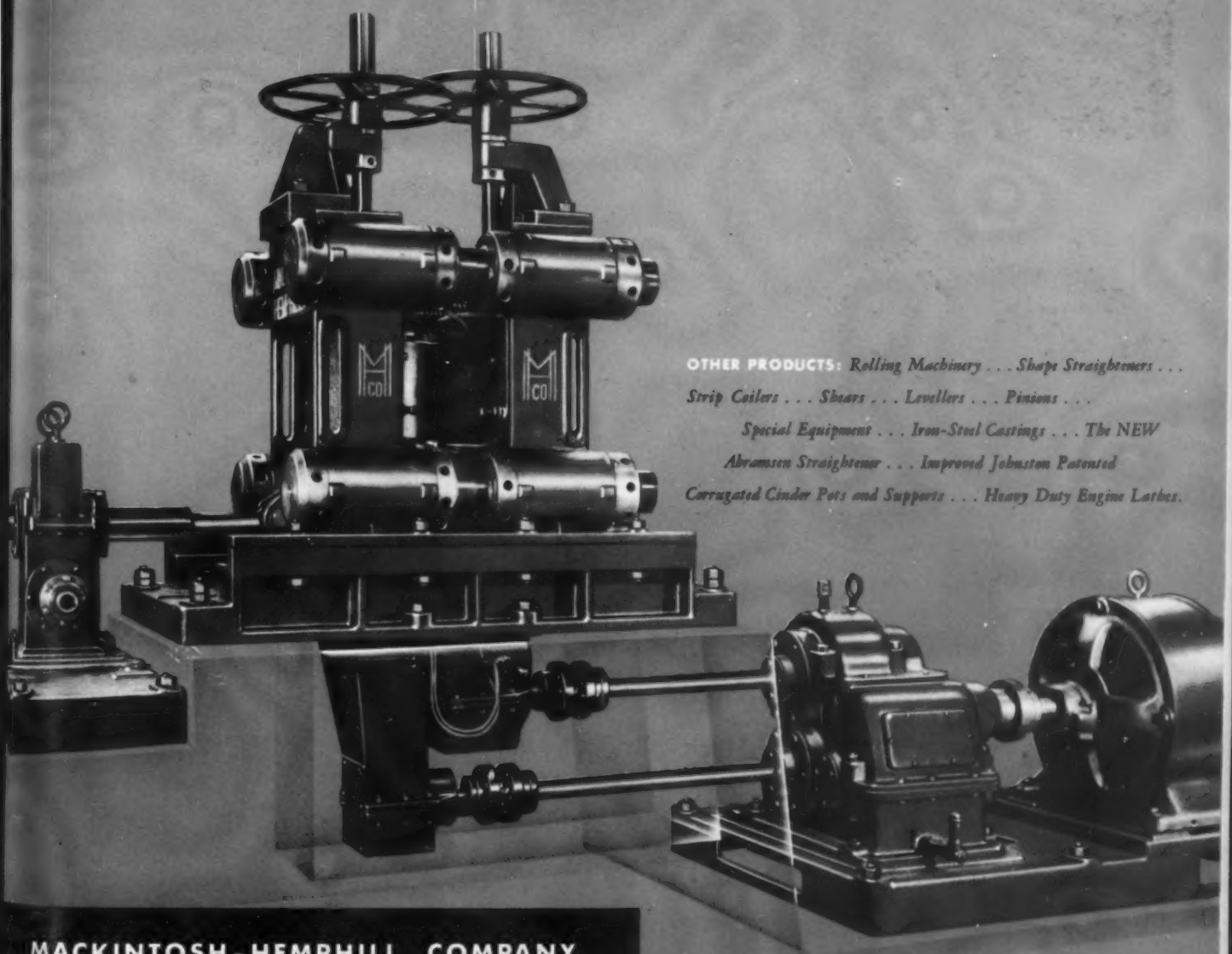
SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG

Here is a vertical precision mill of exceptional accuracy. It handles rounds from 3/16" to 1½" diameter and can be set up to edge shapes and flats. The extremely simple and rigid design of this mill and its easily accessible adjustments and locking devices have helped make it an outstanding success.

Equipment of this kind typifies Mack-Hemp's *advanced industrial thinking* backed up by their perfectly coordinated, balanced and specialized facilities in metallurgy, engineering and manufacturing.

Mack-Hemp is heavy industry's proved and logical approach to increased production, reduced operating costs, higher quality products.

## Rolls hot rounds within cold round tolerances



**OTHER PRODUCTS:** *Rolling Machinery . . . Shape Straighteners . . . Strip Coilers . . . Shears . . . Levellers . . . Pinions . . . Special Equipment . . . Iron-Steel Castings . . . The NEW Abramsen Straightener . . . Improved Johnston Patented Corrugated Cinder Pots and Supports . . . Heavy Duty Engine Lathes.*

**MACKINTOSH-HEMPHILL COMPANY**

PITTSBURGH AND MIDLAND, PA.

*MAKERS OF THE ROLLS WITH THE RED WABBLERS*

# POOLE

COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

# FLEXIBLE COUPLINGS

)OLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

# SELF CONTAINED 2300 VOLT OIL IMMERSED A.C. INDUCTION MOTOR CONTROL

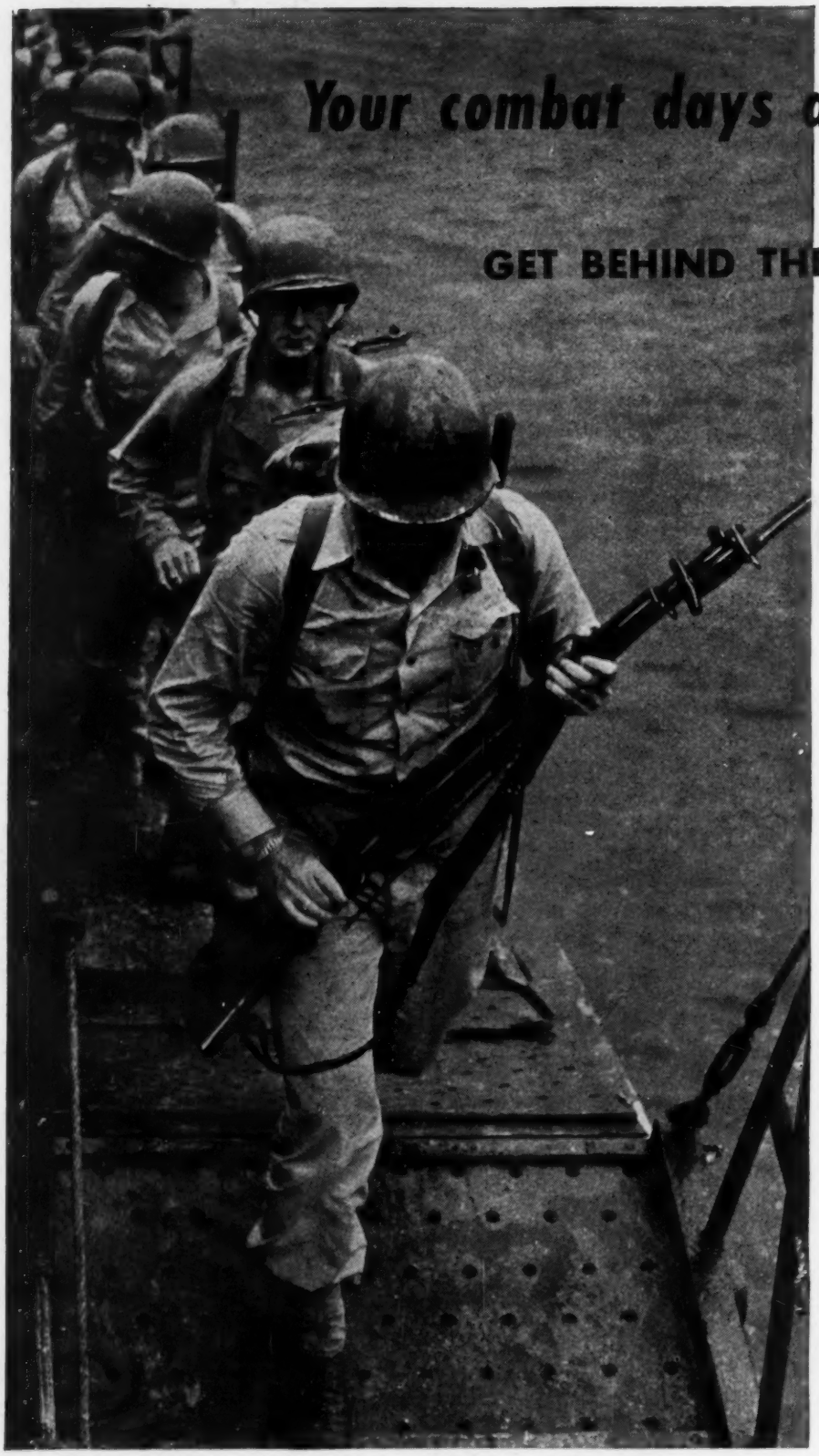
**CONSTRUCTION AND OPERATING FEATURES**

1. They have an especially designed, quick-acting, heavy-duty contactor.
2. High interrupting disconnect fuses, hook stick operated.
3. Self-contained, seal-off motor terminal compartment.
4. Centralized self-contained low voltage control terminal compartment.
5. Magnetic overload relays with electric reset, instantaneous and inverse time element.
6. Self-contained control potential transformer.
7. Self-contained Tank lowering device.
8. Insulated Bus, supported on porcelain Insulators.

The simplicity, efficiency, and flexibility of this Push Button operated Control have been made possible by Rowan Engineers after thirteen years of research, and production of this type of equipment. It has been designed for Engineers whose prime thoughts are safety, continuous operation, minimum installation and maintenance cost. These starters are floor mounted and are arranged for single or group installation. They are Push Button operated; of the full voltage or reduced voltage type; arranged for indoor, or outdoor service; are of cubicle construction and are complete within themselves. *Let us have your 2300 Volt control problems.*

# ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.



## Your combat days are not over!

# GET BEHIND THE VICTORY LOAN!

There's plenty of action ahead for fast-thinking industrial leaders in putting over the new Victory Loan! Your Victory drive is important because:

**EVERY VICTORY BOND HELPS TO**

1. **Bring our boys back to the America for which they were willing to give their lives!**
2. **Provide the finest of medical care for our wounded heroes!**

**BOOST THE NEW F. D. ROOSEVELT MEMORIAL $200 BOND!**

Urge all your employees to buy this new Franklin Delano Roosevelt Memorial $200 Bond through your Payroll Savings Plan! At all times better than ready cash, Victory Bonds are industry's "Thanks" to our returning heroes!

START YOUR VICTORY DRIVE TODAY!

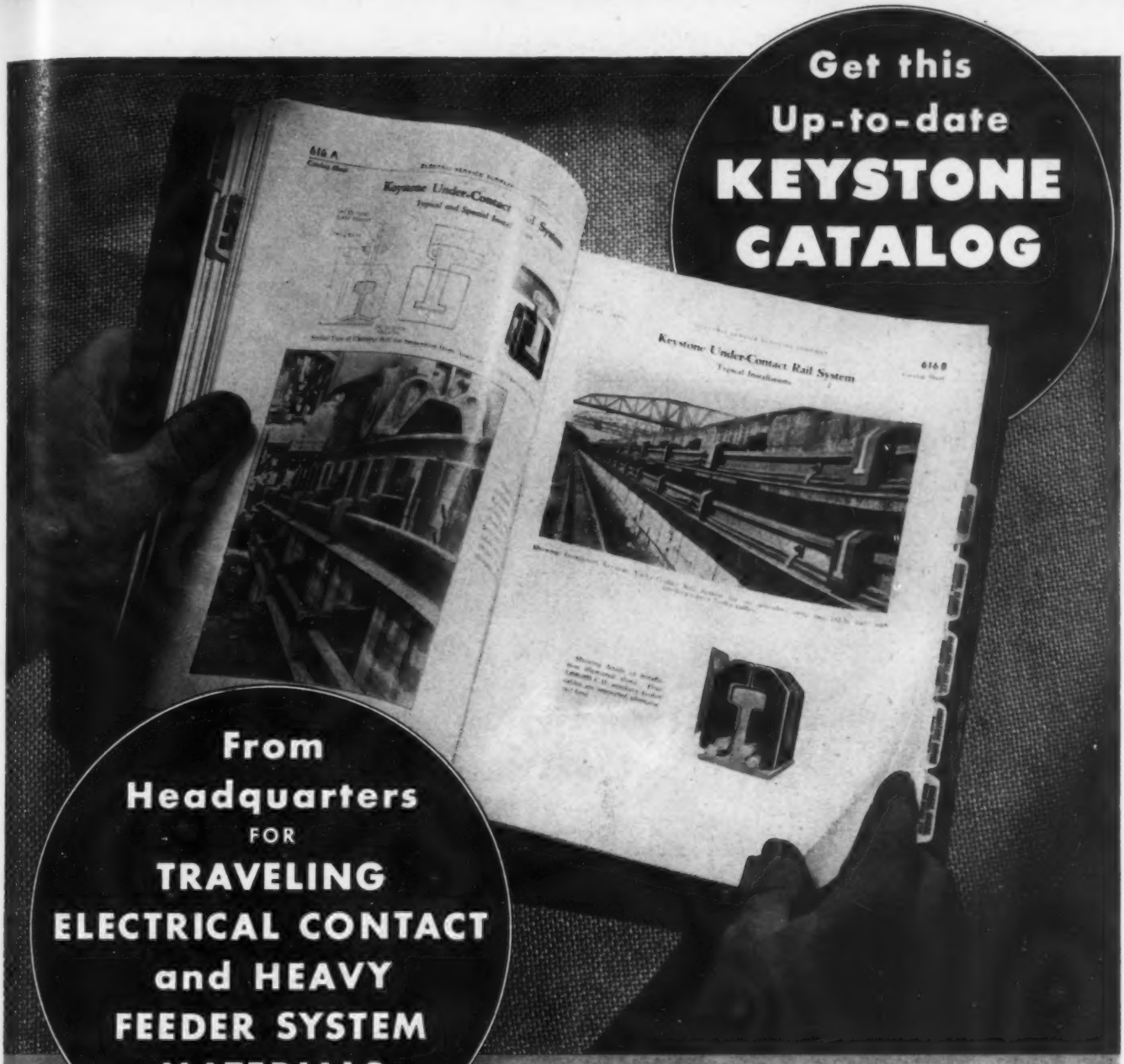
Every Victory Bond aids in assuring peacetime prosperity for our veterans, our nation, your employees—and your own industry!

*The Treasury Department acknowledges with appreciation the publication of this message by*

VICTORY LOAN

*IRON AND STEEL ENGINEER*

★ *This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and War Advertising Council* ★




This catalog will help you. Contains 500 pages listing hundreds of items necessary to maintain crane runways and electrical feeder systems. Ask for catalog "Keystone Electrical Material" if you do not have it in your files.

BUY ANOTHER BOND

**ELECTRIC SERVICE MANUFACTURING CO.**

*Former Name—Electric Service Supplies Co.*

17th & CAMBRIA STREETS • PHILADELPHIA 32 • PA. • Branches in Principal Cities

Left—Type A Safety Switches in 3- and 4-pole; 30, 60, [illegible] and 200 amperes; 125, 250, and 600 volts; fusible type. Without interlocked receptacle for QuelArc plug.
Right—Safety Switch with interlocked QuelArc plug receptacle.

# Heavy-Duty Safety Switches and Circuit Breaker Pylets

## BUILT FOR MILL AND RAILROAD SERVICE

Circuit breaker Pylet with interlocked receptacle and QuelArc plug.

Pyle-National safety switches have the substantial construction needed to withstand severe operating conditions. The case and cover are heavy-section galvanized cast iron; operating parts are of heavy cast metal, and are designed for quick make and break action. Contacts are mounted on heavy slate. The operating shaft has bronze bearings. The case is fully protected, with both cover and hub plates equipped with weatherproof gaskets. The operating lever extends through the case in a rustproof bearing, and the cover is held closed by rustproof wing nuts and bolts. These features assure dependable service and long life even under severe operating conditions.

Circuit breaker Pylets are of similar heavy duty construction, and are available with or without interlocking receptacle for QuelArc plugs.

Write for Pylet general Catalog 1100 with complete listings.

PYLE-NATIONAL
ELECTRICAL EQUIPMENT
• SINCE 1897 •

**THE PYLE-NATIONAL COMPANY**
**1334-58 North Kostner Avenue**
**Chicago 51, Illinois**
*Offices:* New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

**CONDUIT FITTINGS • FLOODLIGHT PROJECTORS**

**LOCOMOTIVE ELECTRICAL EQUIPMENT**

# The Last Word in Industrial Furnaces

● Present-day conditions—changing production programs and reconversion—call for more efficient new furnaces and for bringing old furnaces up to F. E. I. standards.

Performance records on F. E. I. equipment, in important installations, are available for your inspection and show better quality, higher production and greatly reduced cost per ton for the following types of equipment:

**Direct Fired Cover Annealing Furnaces (for coiled strip, tin plate, flat sheets, wire and rod). Also for spheroidizing, normalizing and bright annealing.**

**Galvanizing, Patenting, Lead Annealing and Salt Bath Furnaces for the wire industry.**

**Galvanizing furnaces for pipe, sheet and jobbing plants.**

**Conversion of existing Cover Annealing Furnaces to F. E. I. Direct Fired System.**

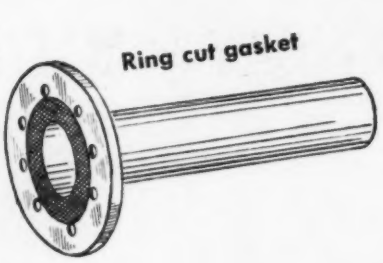
*Let us help you apply advanced F. E. I. principles to your next furnace job. Write for complete information today.*

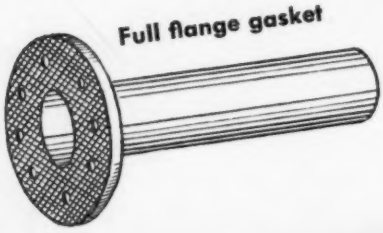
## FURNACE ENGINEERS, *Inc.*

***Specializing in the design, manufacture and installation of furnaces for the metal working industries***

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

# How to Seal Pipe Flanges...




A *ring cut* gasket, properly applied, does a better job than a *full flange* gasket. Here are a few hints that will help:

1. Make sure flanges are perfectly clean and true.
2. Use as thin a gasket as possible for the particular flange condition. (The rougher the flange surfaces, the thicker the gasket needed.)
3. See that the gasket is properly centered and does not project inside the flanges.
4. Pull up the flanges evenly and tightly, alternating from side to side to insure even pressure all around.

## ...and here's the Packing to do the job.

• You won't have to worry about pipe flanges if you seal them with J-M Service Sheet!

This has been proved by thousands of users over many years. That's why Service Sheet is today recognized as the No. 1 sheet packing for high pressure and high temperature conditions against super-heated steam, air, gas, water, hot oil, ammonia, acids, chemicals and many other fluids and gases.

To meet the increasingly severe demands of industry, Service Sheet has been constantly improved. Its dependability and high degree of uniformity are the result of quality and special manufacturing techniques developed in over 75 years of experience in the production of packings.

For further information about Service Sheet and other J-M Packings to meet specialized conditions, write Johns-Manville, 22 East 40th Street, New York 16, New York.

**Johns-Manville**

**PACKINGS & GASKETS**

THERE'S A DISTRIBUTOR NEAR YOU

# BEARING CAPACITY

## *for tomorrow's heavier machine loads...*

ROLLWAY RIGHT-ANGLE LOADING

### Change to Rollway Right Angle Loading

In the drive for postwar production . . . for competitive advantage in postwar markets . . . machines will be pushed to new limits. Bearings which served reasonably well under war conditions will now lack the freedom from service attention, the life expectancy, the load capacity required for satisfactory operations on new peacetime output.

That's when it will pay to change to Rollway Solid-Cylindrical Roller Bearings. Bearings that give you more metal to carry the load . . . longer line contact with the race . . . and lower unit pressures. Rollway Right-Angle Loading splits compound loads into the two components of *pure radial* and *pure thrust* . . . carries each of these on separate roller assemblies. Total load magnitudes per bearing are lower, and are carried perpendicular to the roller axis. There are no oblique resultants, no complicated stresses, no tendency for the rollers to pinch out from between the race. The result . . . less rubbing friction, less roller-end wear back.

**ROLLWAY BEARING CO., INC.**
**Syracuse, N. Y.**

Find out today how Rollway Right-Angle Loading can improve your bearing performance. Just send a print of your assembly with specification of load, speed and type of service for confidential analysis and recommendation. No charge. No obligation.

# ROLLWAY
## CYLINDRICAL ROLLER BEARINGS

SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles

# HUNDREDS OF INSTALLATIONS PROVE THE WORTH OF KEYSTONE Roller Bearing HOUSINGS FOR HEAVY DUTY D. C. MILL AND CRANE MOTORS

The best and possibly the most important motors in your plant deserve the best care they can be given. And a conversion from sleeve to ball bearings should be your first consideration. This conversion as designed by Keystone is economical; yet one of the most successful from every standpoint.

## Important Data on the Keystone Conversion

**S.K.F. Spherical Roller Bearing, 22300 Series.**

**Housings of Electric Furnace Cast Steel.**

**Housings Completely Machined.**

**Bearings are Self-Aligning.**

**Bearings Handle Both Radial and Thrust Loads.**

**No Thrust Collars Required.**

**Ample Clearance Between Shaft and Housing.**

**Neoprene Seals to Retain Grease and Exclude All Dirt.**

*Bearing Specialists*

*The* OHIO BALL BEARING Co.

*BALL-ROLLER and THRUST BEARINGS*

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# Stop Short Circuits

## Reduce Motor Maintenance Cost

TRADE MARK REGISTERED

**NON-FLUID OIL**

IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

**Motors are subject to vibration in a plant like yours. This aggravates the leaking habits of ordinary oil, so that it escapes from bearings and is thrown onto windings causing short-circuits.**

**NON-FLUID OIL corrects this evil, and reduces cost because it does not creep or throw, outlasting oil 3 to 5 times. Experience shows that NON-FLUID OIL provides cleaner, more dependable lubrication and constant bearing protection.**

**NON-FLUID OIL is saving money for thousands of plants, because it lasts longer and needs less frequent application.**

*Write for Descriptive Bulletin.*

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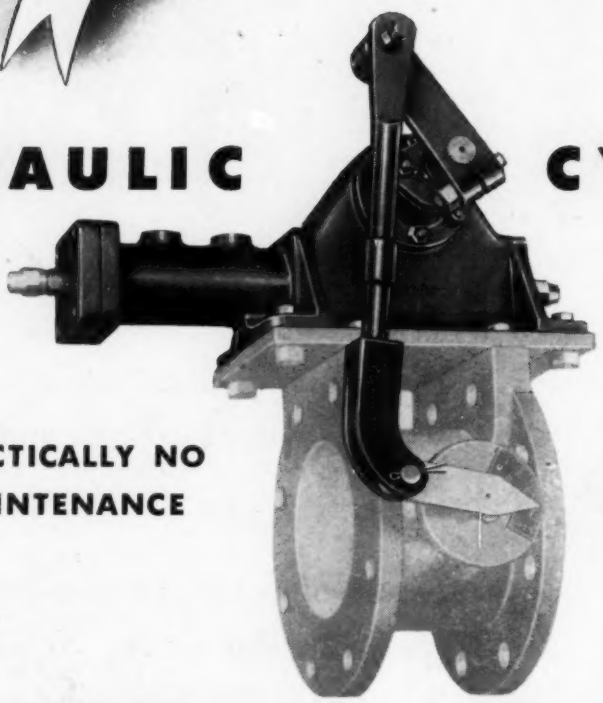
*NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our exclusive manufacture.*

# ASKANIA

CRANK-TYPE

## HYDRAULIC CYLINDERS



PRACTICALLY NO MAINTENANCE

VIRTUALLY LEAK-PROOF

*A Flexible Source of Hydraulic Power*

The outstanding feature concerning Askania Crank-Type Cylinders which engineers talk about is that once they are installed and set, you can forget about them! That's true because these cylinders, employing a rotary shaft, are inherently more oil-tight than the reciprocating type.

The ground ringless pistons not only provide almost fictionless operation . . . but they also keep maintenance at an irreducible minimum.

Bulletin 126 describes the characteristics of Askania Crank-Type Cylinders in detail. Write for your copy today.

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A GENERAL PRECISION EQUIPMENT CORPORATION SUBSIDIARY

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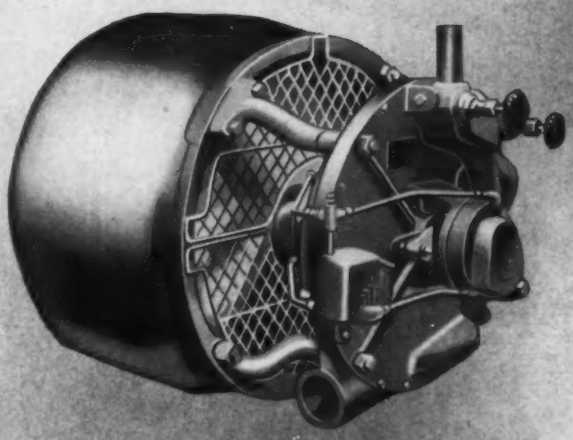
WING



**WING TURBINE DRIVEN BLOWERS**

**Type K**

**For Brickwall Mounting**

*Generally used for Stoker or Bagasse Firing where casing is cemented into Boiler Wall*

Wing pioneered in forced-draft turbine blowers over a third of a century ago. Today Wing Turbine Blowers are in use in thousands of installations in many varied industries. They are simple and rugged in construction, quiet and dependable in operation. Oil-free exhaust can be used for heating, process or feed water.

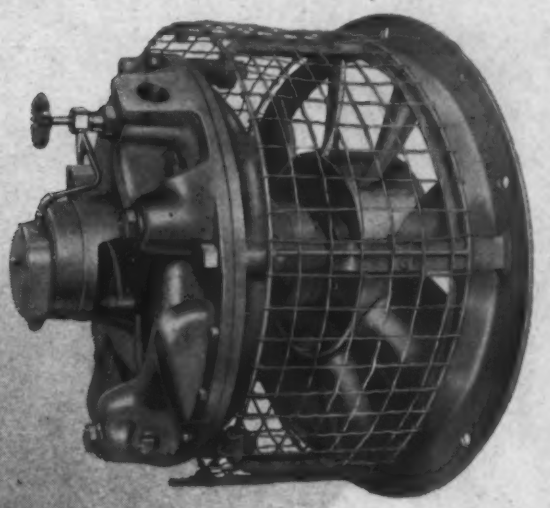
**WING TURBINE DRIVEN BLOWERS**

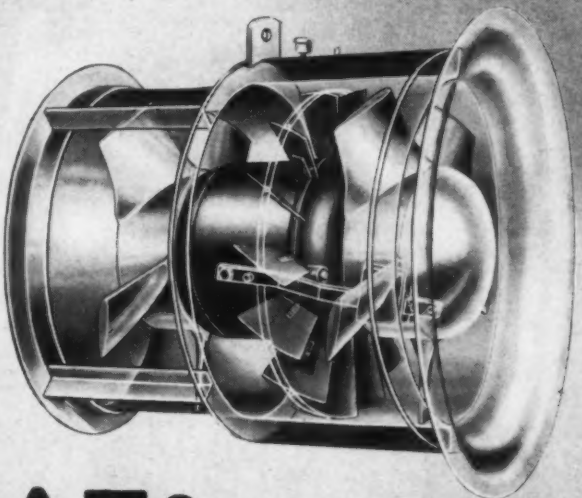
**Type R**

**For Horizontal or Vertical Mounting on Wind Boxes or Air Ducts**

*Generally used for Oil Firing on Marine and Stationary Boilers, for Marine Ventilation, etc.*

Ideal where use can be made of exhaust steam or where electricity is not available. Flexible capacity regulation by throttling steam to turbine—manually by hand valve or automatically by combustion control. Prompt shipments (no waiting for motors).





**WING MOTOR DRIVEN BLOWERS**

**TYPE COM (TWO STAGE)**

**TYPE EMD (SINGLE STAGE)**

Wing Motor Driven Blowers are axial flow forced draft blowers of simple, rugged construction, compact design and highest efficiency. Type EMD has capacities up to 50,000 CFM with statics to 5″. Type COM can handle statics up to 30″ on special designs.

**Write for Bulletin SW-1**

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*Factories: Newark, N. J. and Montreal, Canada*

**Wing AXIAL FLOW BLOWERS**

*To executives responsible for rapid reconversion to peacetime production*

# SHORTENED DELIVERIES OF D-C MOTORS AND M/G SETS NOW IN VIEW

Crocker Wheeler's reconversion is completed. We had no great problem. The special items built for war use, such as trench mortar bombs, .30-caliber airplane training turrets and Sherman tank turrets, were completed long ago and the Company's basic products — electric motors and generators — are essentially the same for peacetime application.

This means that we are today in a better position to produce electrical equipment for the steel industry than we have been at any time during the last five years. In fact, we can promise "better-than-pre-war" deliveries on large equipment, as supplies of raw materials become more abundant.

For the last fifty years a large portion of our plant capacity has been devoted each year to the manufacture of equipment for the steel industry. This equipment has included: Direct-current motors in sizes up to 5,000 hp for main roll drives and for operating slab squeezers, trimming shears, levelers, etc.; motor-generator sets to supply power for main motors, auxiliaries, cranes and hoists; and standardized mill motors for auxiliary drives and heavy-duty crane applications.

We continued to serve the industry to the best of our ability through the war years. Now, with fewer factors "beyond our control", we can serve you *faster*. If you need electrical equipment for rapid reconversion, call on us. Our facilities are at your service.

E W Amy

General Manager

**CROCKER-WHEELER DIVISION • JOSHUA HENDY IRON WORKS**

Ampere 20, New Jersey

CW-10

# PUT "Balanced Proportion" PERFORMANCE IN YOUR ROLLING MILLS

Get full Anti-Friction Bearing performance with Timken "Balanced Proportion" Roll Neck Bearings. They are the culmination of nearly 25 years of constant engineering and metallurgical development. They bring to mill operators new and vital advantages resulting from this unmatched accumulation of specialized knowledge and experience.

With Timken "Balanced Proportion" Roller Bearings you get:

A scientifically correct bearing design giving you—

a—Maximum bearing capacity for the usual mill roll diameter for which it is designed.

b—Maximum roll neck strength, for the mill separating force capacity of the bearing.

c—Minimum roll neck deflection for the given mill separating force.

The photograph, reproduced by courtesy of Mesta Machine Company, Pittsburgh, Pa., shows one of the pioneer Timken "Balanced Proportion" Back-up Roll Neck Bearings being assembled in its chock. This bearing, and a lot more just like it, are in the Aluminum Company of America rolling mill at Alcoa, Tennessee. This mill was installed in 1941 and has been in continuous operation ever since.

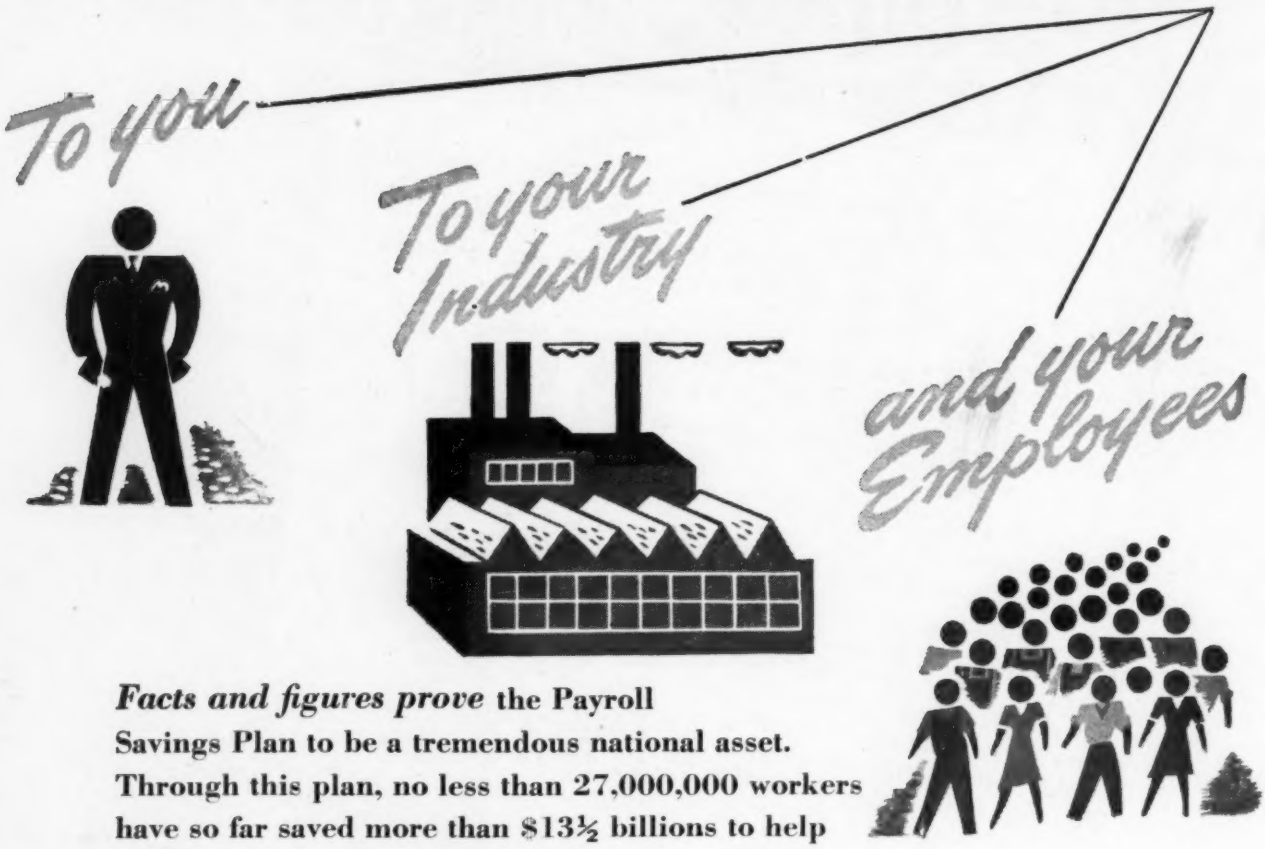
For additional specific information covering Timken "Balanced Proportion" Bearings consult our engineering department. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

# *what the* PAYROLL SAVINGS PLAN *means*




***Facts and figures prove*** **the Payroll Savings Plan to be a tremendous national asset. Through this plan, no less than 27,000,000 workers have so far saved more than $13½ billions to help speed victory . . . forestall inflation . . . and build peacetime prosperity!**

Did you know that yours is one of 240,000 companies maintaining a Payroll Savings Plan? Not only is this combined effort fostering national security, but also creating a lucrative postwar market for you . . . and all American industry!

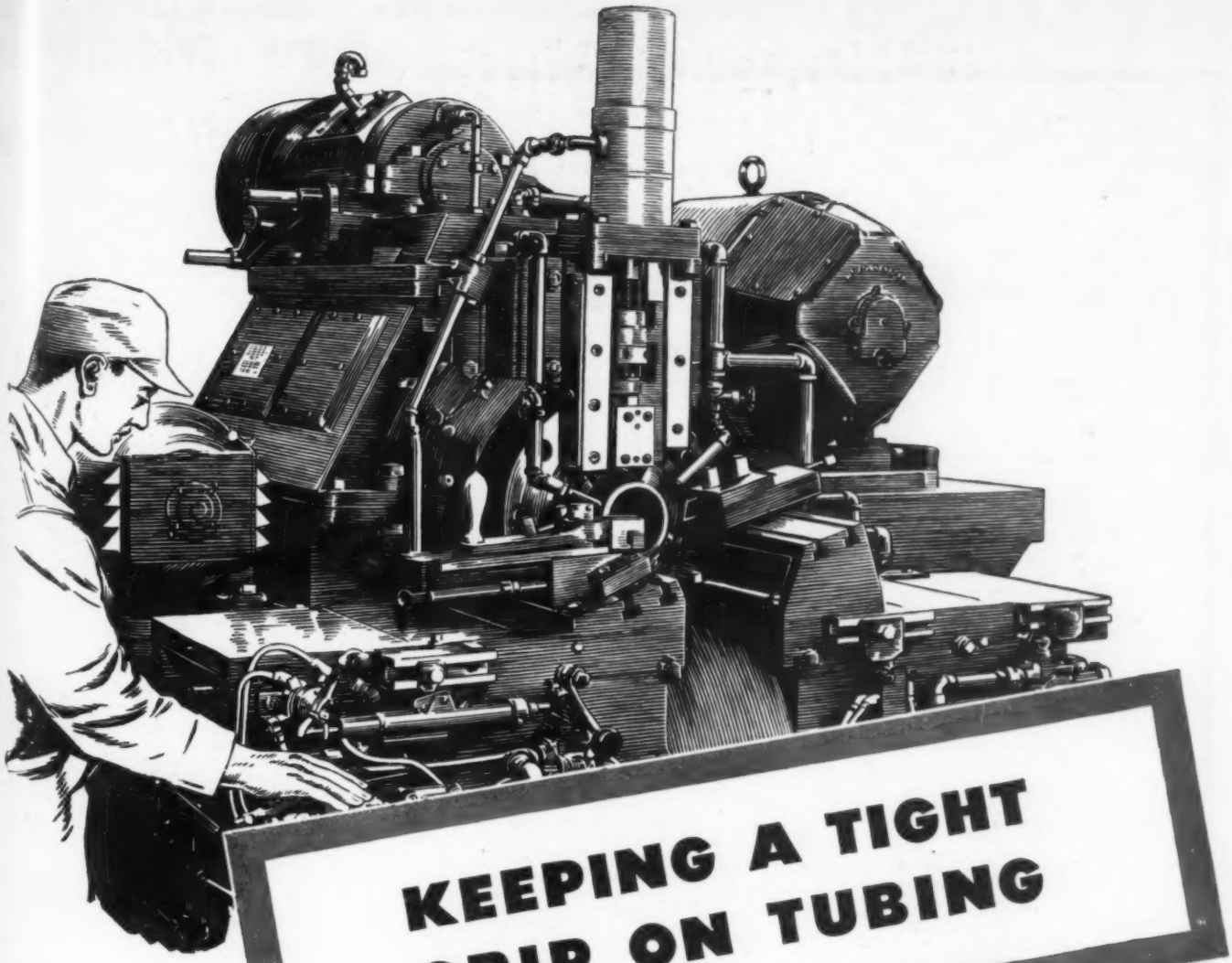
Have you realized that 76% of all employed in industry are now enrolled in the Payroll Savings Plan . . . averaging a $25 bond each month per employee? Through this plan, millions are now looking forward to homes, educational opportunities and old age independence!

Surely, so great an asset to your country, your company and your employees is worthy of your continued . . . and increased . . . support! Now is the time to take stock of your Payroll Savings Plan. Use selective resolicitation to keep it at its 7th War Loan high! Keep using selective resolicitation to build it even higher!

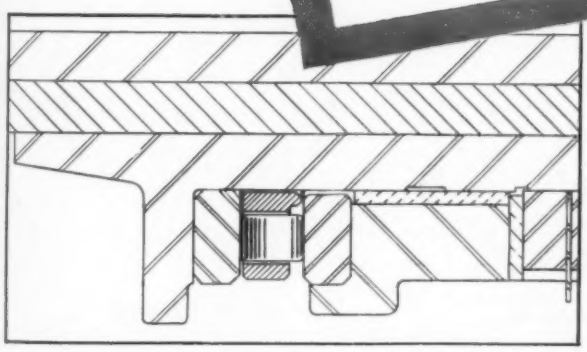
*The Treasury Department acknowledges with appreciation the publication of this message by*

## IRON AND STEEL ENGINEER

*This is an official U.S. Treasury advertisement prepared under the auspices of the Treasury Department and War Advertising Council*



# KEEPING A TIGHT GRIP ON TUBING



*X-Section of 17¼" I.D. x 22" O.D. Torrington roller thrust bearing, which is mounted on a hollow spindle and carries the thrust load that is used to close the gripper chuck during the cutting-off operation. Bearing capacity is 179,500 lbs. at 100 R.P.M.*

This Taylor-Wilson Tube Cutting-Off machine is representative of the wide variety of uses to which Torrington Bearings are put where maintenance time-out would seriously hamper production. In the designing of the gripper chuck for this machine, a tight, unfailing grip was necessary to prevent slippage under the extreme pressure of the high-speed cutting-off operation. And it was of prime importance that the bearing used to close the chuck while the tube was being cut off be rugged, efficient and dependable.

A long-life, trouble-free Torrington roller thrust bearing was the logical solution to the problem, and the severe, full-schedule operation of these tube cut-off machines has proved again the ability of Torrington Bearings to help modern equipment do a better job.

Designing and building large, heavy-duty bearings for back-up rolls, screw downs, roll necks, shears, edgers, strip reels and other steel mill equipment is an everyday function of Torrington's Bantam Bearings Division. Our engineering department is ready at all times to cooperate with you in solving your friction problems, whether routine or unusual.

**THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION**
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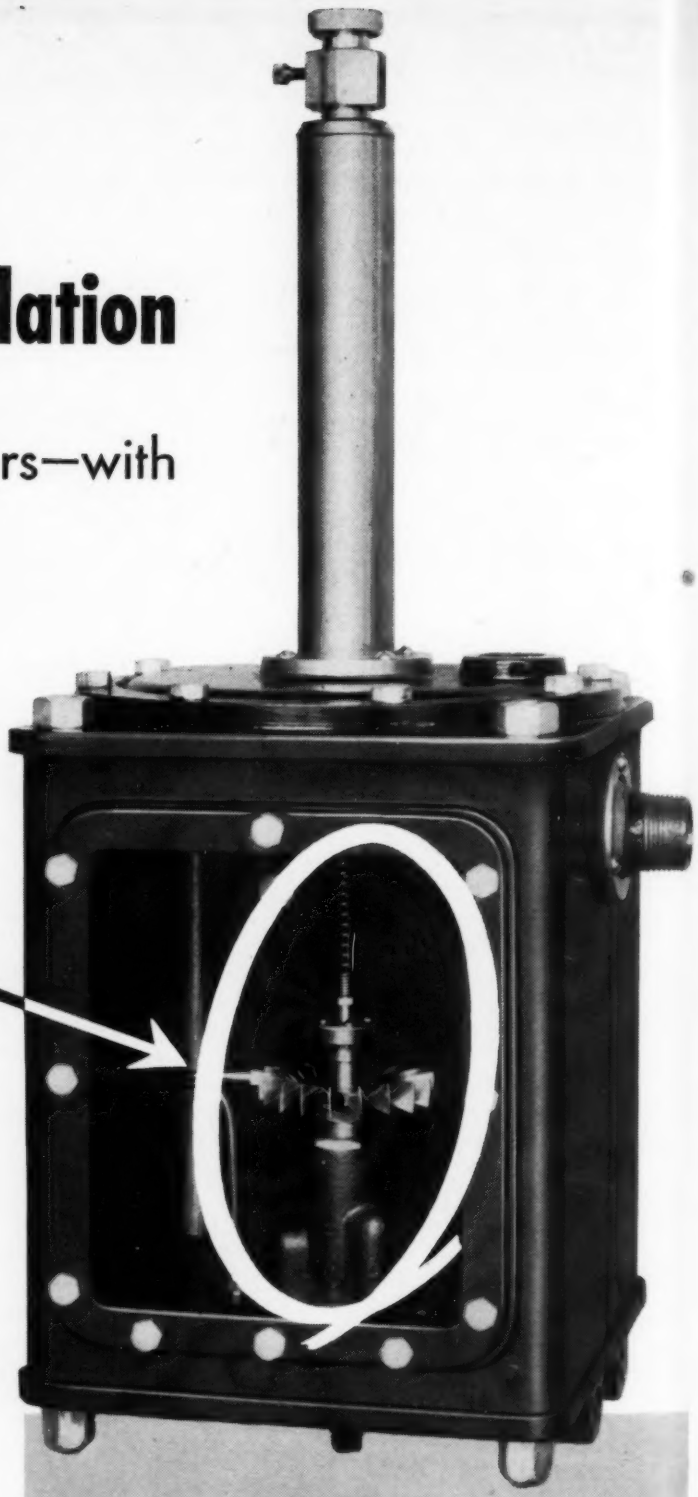
# Accurate Regulation

## of the heaviest dampers—with

## HAGAN

## SPINNING

## PILOT VALVE



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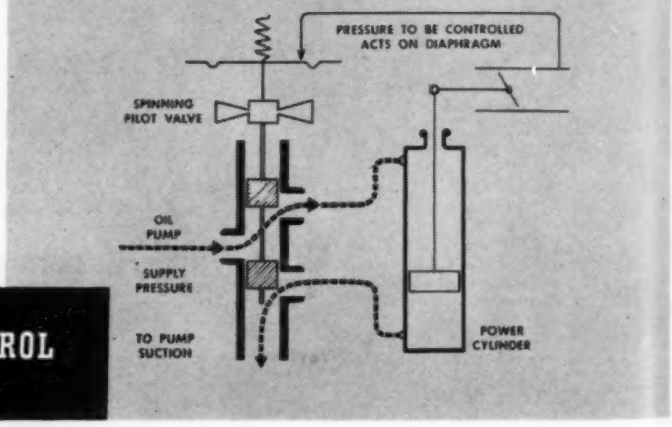


HAGAN *Automatic* COMBUSTION CONTROL
*The pioneer . . . and still the leader*

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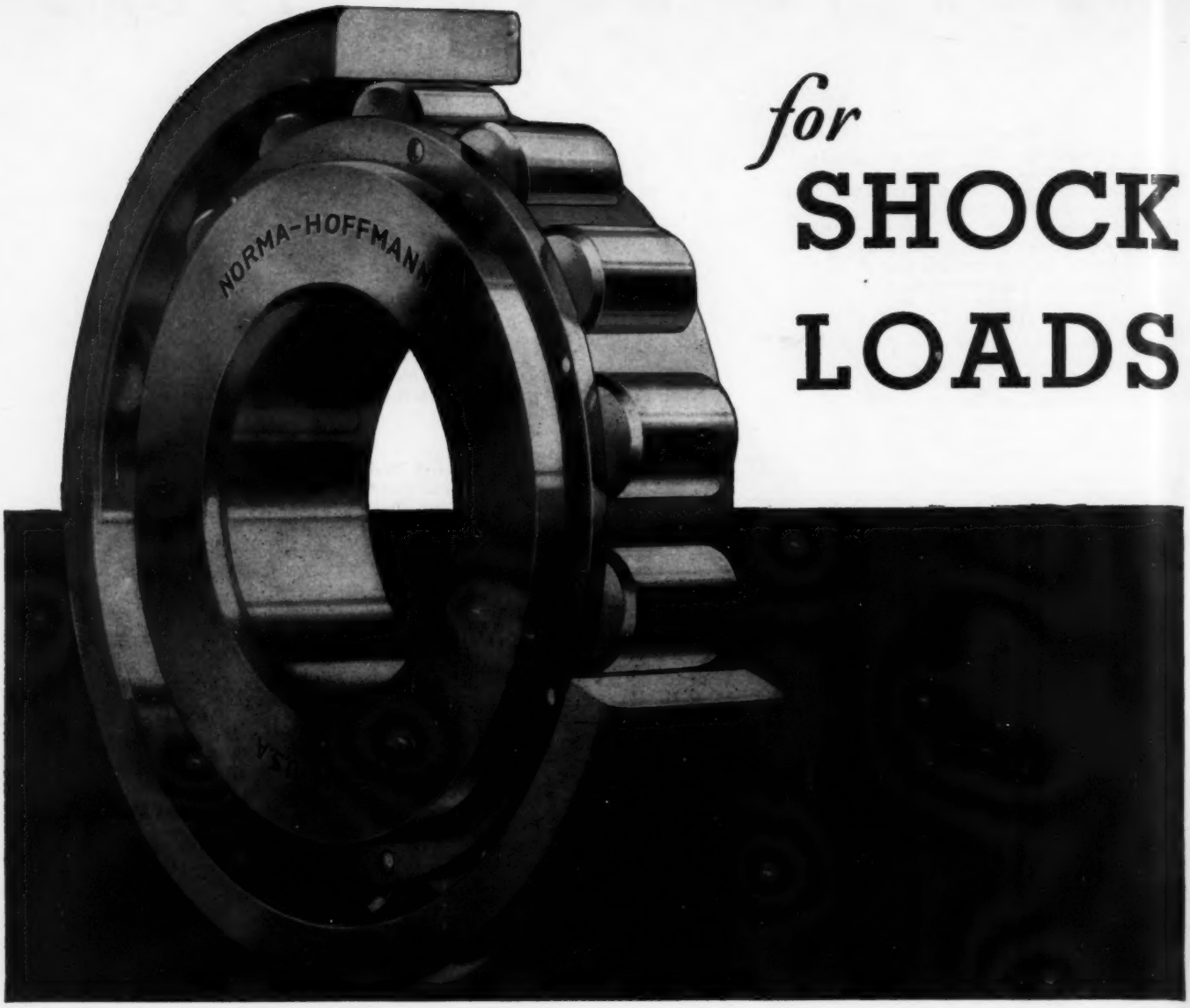


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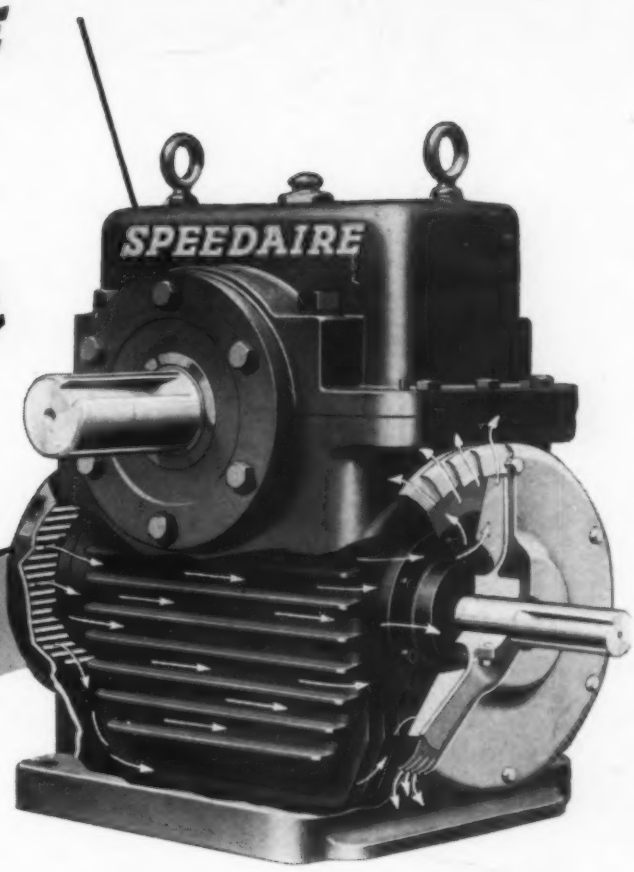

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"Now we're hearing about Speedaire—Cleveland's New Fan-Cooled Unit that delivers more horsepower per dollar. We're always interested in bigger returns —so Speedaire, backed by Cleveland's good name, is going on our new equipment from here on."

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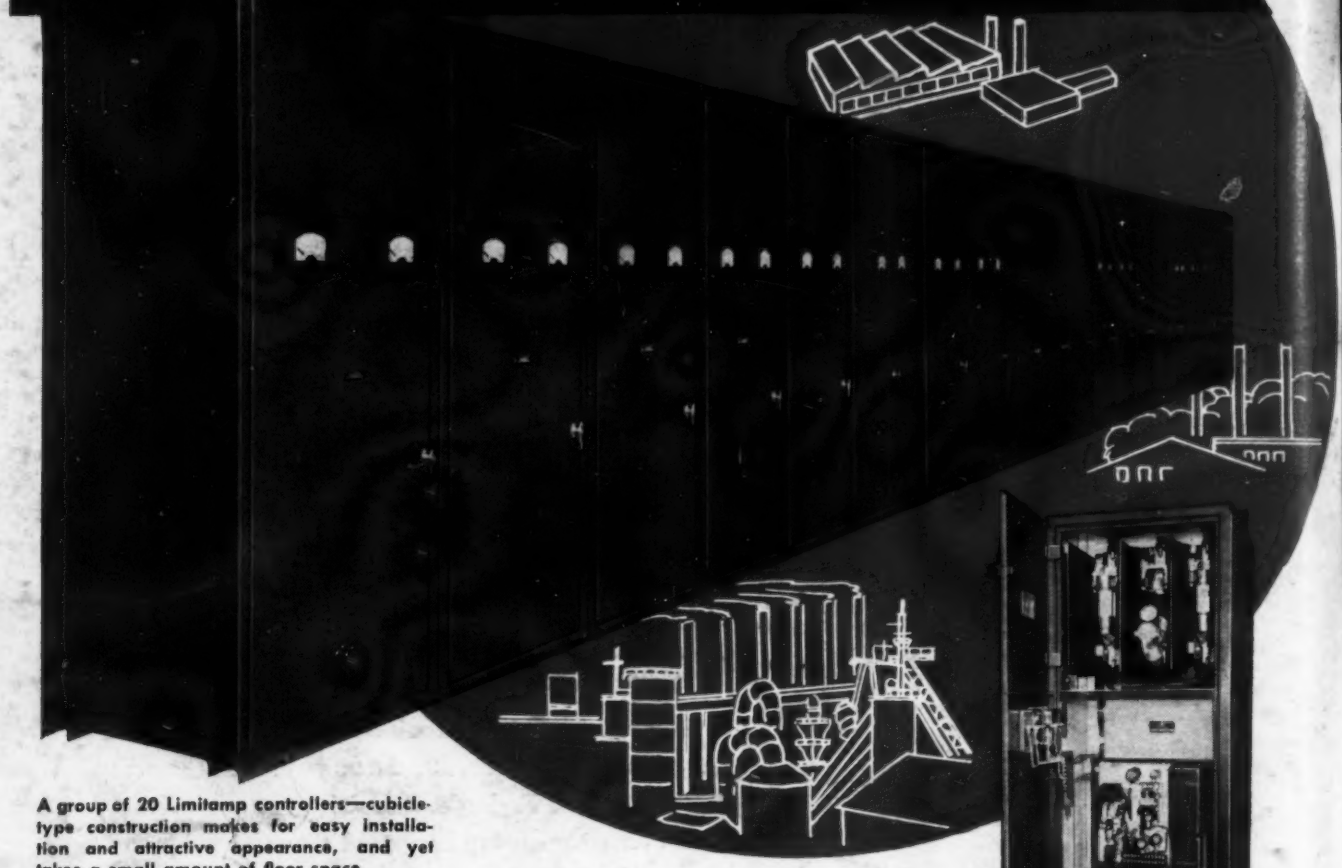
# 2300-VOLT PACKAGED CONTROL FOR SURE, SHORT-CIRCUIT PROTECTION



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